This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google™ books

https://books.google.com

TJ
870
.M6

S. Morgan Smith Company

York, Pa. U.S.A.

MANUFACTURERS OF

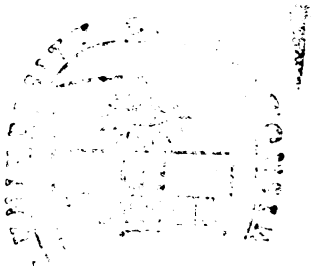
TURBINE WATER WHEELS

AND

POWER TRANSMITTING MACHINERY

SIXTH EDITION

Digitized by Google

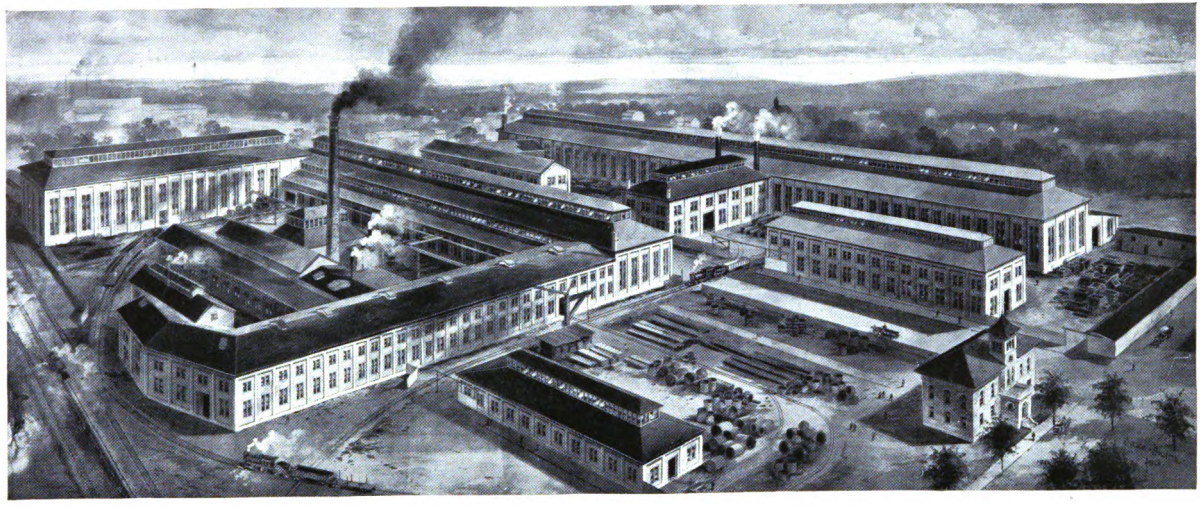


Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google



WORKS ON P. R. R. AND W. M. R. R.

Digitized by Google

DESCRIPTIVE CATALOGUE

THE

"McCORMICK" TURBINE

MANUFACTURED
BY

S. MORGAN SMITH Co.
YORK, PENNSYLVANIA, U. S. A.

Digitized by Google

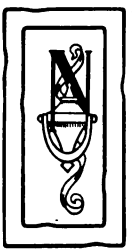
COPYRIGHT 1904
By
S. MORGAN SMITH CO.

Press of
The Republican Publishing Co.,
Hamilton, Ohio.

Digitized by Google

TJ
870
.M6

PREFACE



EVER before in the history of our country has the demand for a first class Turbine been greater than at the present time. Many streams that once afforded an abundant supply of water for the factories and mills located along their banks, are no longer adequate to the demands made upon them.

Turbines once thought to be economical in the use of water are now found to be quite wasteful and must give place to wheels of more modern design.

In view of these facts we have spent large sums of money in order to produce a Turbine equal to the demands of the times. In this we have been successful, and now offer to our many friends and patrons the "McCORMICK," *a wheel simple in construction, durable in all its parts, and what is of the greatest importance, a wheel* USING *less* WATER *per horse power when running from half to full gate than any turbine ever offered to the public.*

Our large new shops located directly on the lines of the Pennsylvania and Western Maryland Railroads, are equipped with the most modern tools and are especially adapted for the handling of heavy work.

Those contemplating the purchase of Water Wheels and Machinery will find it to their interest to correspond with us, as we are willing to guarantee results where others have failed.

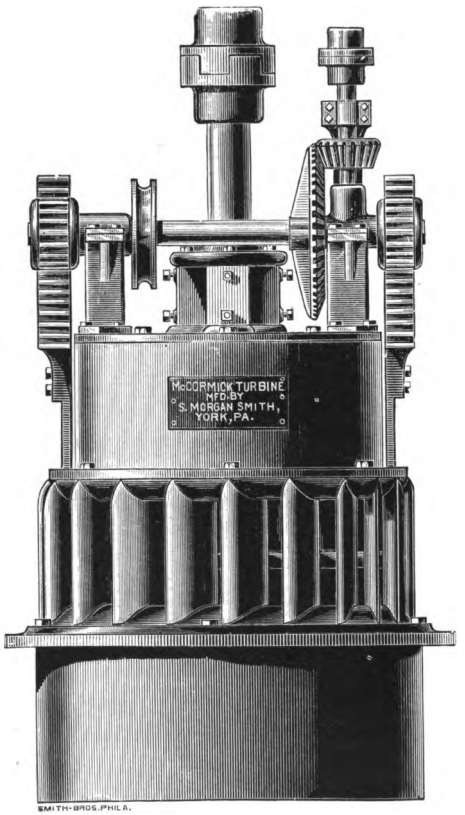
S. MORGAN SMITH CO.

YORK, PA., U. S. A.

Digitized by Google

"THE McCORMICK"

Uses less water per horse power than any other Water Wheel.



ENGRAVING No. 1.

Digitized by Google

DIRECTIONS FOR THE CONSTRUCTION OF HEAD AND TAIL RACES.

THE HEAD RACE.

In constructing the canal or head race, a very frequent error is committed by failing to give it sufficient capacity. It should be *wide* and *deep,* and especially where the race is of considerable length, and a large quantity of water is to pass through it. As a general rule, the water should not flow faster than from 60 to 120 feet per minute. Where there is a long race, after the wheel has been running three or four hours the head frequently draws down from one to three feet. The effect of this is the same as if the dam had been lowered an equal distance—resulting in a loss of power which would have been prevented by making the race as wide and deep as it should be.

When the water is to be conveyed to the turbines through iron pipes, the receiving ends of the pipes should be well submerged, so as to prevent any possibility of their drawing air. The velocity of the water through the pipes should not exceed three feet per second for short pipes, and as the length of the pipe increases the velocity should be reduced, until in pipes 200 to 250 feet in length, the velocity should not exceed two feet per second. It is, however, often necessary to run the water at a greater velocity than above named. See table giving the loss of head in different size pipes at different velocities.

THE TAIL RACE.

This should be wide and deep, and the level of the bottom of the wheel pit should be carried from five to ten feet below the end of the forebay or flume, and if possible it should be carried out to the bed of the stream, as no tail race for even small wheels should have less than two feet of dead water in it before the wheels are put in motion, and where large wheels (using a great deal of water) are to be used, the tail race should have three or four feet of dead water in its entire length. By having tail race thus constructed, as soon as the water is discharged from the wheel or wheels, it will push out or displace the dead water in the race, thus preventing a loss of head For instance, to be more plain, suppose the bottom of tail race is on a level with the water in main stream into which tail race discharges, when wheels are started the water in tail race would rise in proportion to the width of race and quantity of water flowing therein, and reduce the working head in proportion; while if the race were as first above stated, the water from the wheels would displace the dead water without rising above the water in the main stream, thus utilizing the full amount of head. *From one to three feet of working head is often lost for want of proper depth and width of tail race.*

Digitized by Google

WHEEL PIT.

Here is where millowners and millwrights, in putting in turbine wheels, are more liable to err than elsewhere. Whether under high or low heads, the pit should be deep and wide. There is no case where this is more important than where a large wheel is run under a low head; as under these circumstances no loss of head, however small, can be afforded. A pit of insufficient size causes the water to react upon the wheel; an additional loss of power is also caused by the fact that a portion of the head is consumed in forcing the water out of the pit when there is not sufficient outlet. As a rule the depth of the pit should not be less than the diameter of the wheel for wheels under 20 inches in diameter. Larger wheels should have an opening under them at least one and a half times as great as their diameter.

Water has but 100 per cent in it, and a wheel that takes out from 80 to 85 of that per cent leaves but little force in it. To expect that the water coming through our wheels will have power to wash the sand and gravel out of its own pit, is to expect what will not be realized. Hence in putting in wheels do not calculate upon the water in the wheel pit to do any work for you. If you find it foaming and dashing in the pit, then rest assured that your pit is either too shallow or too narrow, or both.

SETTING WHEELS ABOVE TAIL WATER.

Sometimes in adapting wheels to high and even low heads, it becomes necessary to set the wheel some distance above the tail water and conduct the water from the wheel through a Draft Tube. As good results may be obtained when the wheel is set in this manner, as though it were placed at the bottom of the fall; *provided* this Draft Tube is perfectly air-tight, and its mouth submerged from 4 to 10 inches below the surface of tail water. As a rule we advise that the wheel be set at the bottom of the fall. In all cases when a Draft Tube is used, it should be made of Iron, so as to secure durability and *perfect tightness*.

WARRANTEE.

Any wheel or wheels that are properly put in, according to directions given, and geared to run when full at work the number of revolutions per minute stated in Tables for the Head of Water they may be working under, failing to give the power claimed in tables of this pamphlet, can be returned, if not broken, to the station to which they were shipped, any time within sixty days, and the money received for such wheels will be refunded. If purchaser finds it impossible to put wheel in and give it a trial within the sixty days allotted, and wants more time it will be granted on application, not exceeding in all ninety days from date of shipment.

S. MORGAN SMITH CO.

Digitized by Google

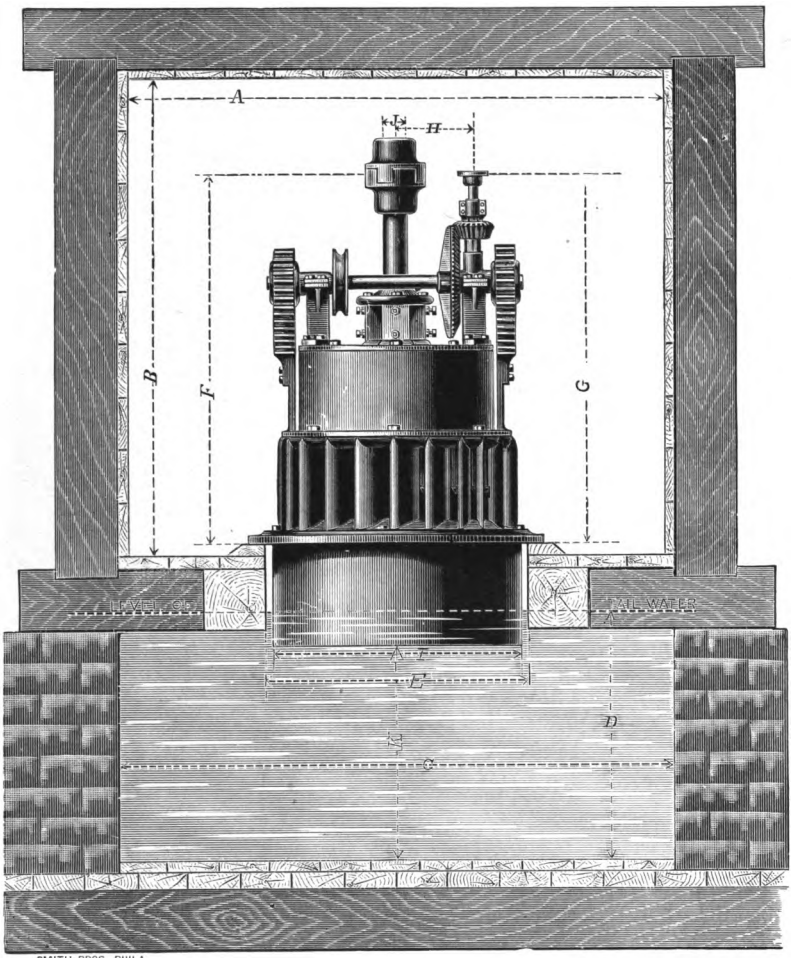
DIRECTIONS FOR SETTING WHEELS.

In setting the "McCormick" Turbine in a wooden penstock, the first thing to do is to see that the floor of the flume is level, generally a ring made of soft wood is placed on the floor around the hole, on which the draft tube flange of the wheel, which is faced off, is set. It is very important that the flume be built on good foundations so as not to settle when the water is let in; a very good plan, and especially where large wheels are to be set, is to put four posts or iron columns under the timbers around the hole in the floor through which the draft tube passes.

The step and all bearings of the wheels are carefully adjusted before leaving the shops. Large wheels are, however, shipped in sections and while it is not likely, yet it is possible for the tramming screws in the step to be moved, so as to require readjustment. This should be looked after as the wheel is being put together in the flume. The draft tube is always first set in position, then the runner, or wheel proper, is placed on the step; afterwards comes the guide rim, and so on until all parts are together.

When the step is properly adjusted, there should be a space between the top of band on runner and bottom of inner edge of guide rim of one thirty-second of an inch. Care should also be taken lest the follower blocks in packing-box are not drawn too tightly around the wheel shaft. When the wheels are not to be run for sometime, the step and step-shoe should be well covered with tallow to prevent rusting. In order that gates may work easily all wheels over 24 inches are provided with chain and weights to counterbalance the weight of the gate. These weights can be used either inside or outside the penstock. When possible it is best to have them on the outside.

Digitized by Google



ENGRAVING No. 2.

Shows Turbine in wooden flume. See dimensions on page 9.

Digitized by Google

DIMENSIONS

Of Turbines and Penstocks in Inches.

Lettered columns correspond with letters in engraving on page 8.

Diameter of Wheel.	A	B	C	D	E	F	I	J	K
9	36	33	33	24	16	22	14¾	1⅝	18
12	42	48	45	28	20	35	18¼	2⅛	22
15	48	54	60	34	25	41	23⅛	2⅜	28
18	54	58	69	40	28	44	26⅜	2⅞	34
21	63	66	78	45	33	50	30¾	3⅛	39
24	72	69	87	51	37	55	34⅞	3⅜	45
27	84	72	96	56	42	57	39½	3⅝	50
30	90	78	108	62	46	63	43⅝	3⅞	56
33	102	90	120	66	51	73	48¼	4⅛	60
36	108	96	132	72	54	78	52	4⅝	63
39	120	102	144	78	59	82	56⅝	5⅛	69
42	126	105	156	81	64	85	61⅜	5⅜	72
45	138	108	168	84	68	90	65⅜	5⅞	75
48	144	114	180	90	72	96	69¼	6⅜	81
51	153	126	192	99	76	105	73¾	6⅞	87
54	162	135	204	105	81	111	78	7⅜	93
57	168	138	216	111	85	114	82⅛	7⅞	99
60	180	144	228	117	89	118	85⅞	7⅞	105
66	192	150	240	123	96	121	90¾	7⅞	111
72	204	156	252	129	101	123	96⅝	7⅞	117

Digitized by Google

TEST AND TABLES OF THE "McCORMICK."

The tables of the McCORMICK WHEEL are based on actual tests made in the Holyoke Testing Flume—the only reliable testing flume in the country. Both Right and Left hand wheels, of each size, have been tested and brought to over 80 per cent efficiency. Although our tables are only based on 80 per cent useful effect from the water used, all of the wheels have exceeded 80 per cent in the tests, some of the larger sizes having run over 85 per cent at less than full gate, with an average of more than 80 per cent from half to full gate. (Gate opening means the quantity of water—not the gate opening.)

Like results have never been obtained from any other make of wheel.

The McCORMICK wheels, when properly set, are guaranteed to develop the power and speed claimed for them in this catalogue.

When comparing the tables of the McCORMICK wheel with those of other wheels, satisfy yourself that the tables of those wheels are reliably made. Many water wheel builders have tabled their wheels at 80 and even 90 per cent, when if the truth were known, their wheels in actual test would not exceed 60 to 70 per cent.

Before purchasing a wheel be assured that the tables of the particular size wheel you require are based on actual tests made in the new flume of the Holyoke Water Power Company.

Water powers are becoming more valuable each year, and manufacturers cannot afford to run wheels which sacrifice water and give but little power.

The following rule will enable you to determine the percentage at which any wheel is tabled.

RULE.

Multiply the cubic feet of water by 62½, which is the weight of one cubic foot of water; multiply the product by the *head*, which will give the foot pounds; divide that product by 33,000, which gives the *full horse power of the water;* divide the horse power *claimed* by the *full horse power* of the water, and the result will be the percentage at which the wheels are tabled.

Digitized by Google

THE "McCORMICK" AS COMPARED WITH OTHER WATER WHEELS.

Prices quoted on the McCORMICK, are for the wheels complete, as shown on page 4, including a section of chain and balance weights for gates, delivered free on cars at our works. All wheels 24 inches and smaller will be shipped together, ready to set in flume. For convenience in handling, large size wheels will be shipped in sections with the smaller parts boxed.

When comparing the cost of the McCormick with that of other water wheels, do not fail to compare the horse power also.

Prices on vertical and horizontal shaft wheels will be quoted on application.

Those wishing to put in horizontal shaft wheels will please describe their power and location, and if not too much trouble, send a sketch of the same, no matter how crude. Much valuable time is often saved by sending a drawing or sketch, showing location for water wheels and machinery.

We emphatically state that there is not a water power plant in existence (unless under very high heads), which cannot be very materially benefited, and the power increased (with the same quantity of water) by the use of "McCORMICK TURBINES," no difference what kind, or whose wheels are in operation or at what figures of SUPPOSED efficiency they are tabled.

We are especially desirous of conferring with those whose power plants are unsatisfactory, and where *others have failed* we are ready to guarantee results providing our advice is followed.

Digitized by Google

9-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	297	204	1.5
6	325	223	2.0
7	351	241	2.6
8	375	258	3.1
9	398	273	3.7
10	420	288	4.4
11	440	302	5.0
12	460	316	5.7
13	479	329	6.5
14	497	341	7.2
15	514	353	8.0
16	531	365	8.8
17	547	376	9.7
18	563	387	10.5
19	579	397	11.4
20	594	408	12.3
21	608	418	13.3
22	623	428	14.2
23	637	437	15.2
24	650	447	16.2
25	664	456	17.2
26	677	465	18.3
27	690	474	19.3
28	702	482	20.4
29	715	491	21.5
30	727	499	22.6
31	739	508	23.8
32	751	516	24.9
33	763	524	26.1
34	774	532	27.3
35	785	539	28.5
36	796	547	29.8
37	807	554	31.0
38	818	562	32.3
39	829	569	33.5
40	840	577	34.8

See page 32 for Table of 9-inch Wheel under heads of 41 to 100 feet.

Digitized by Google

12-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	223	355	2.7
6	244	389	3.5
7	263	420	4.4
8	282	449	5.4
9	299	476	6.5
10	315	502	7 6
11	330	527	8.8
12	345	550	10.0
13	359	573	11.2
14	373	594	12.6
15	386	615	13.9
16	398	635	15 4
17	411	655	16 8
18	422	674	18.3
19	434	692	19.9
20	445	710	21.5
21	456	728	23.1
22	467	745	24.8
23	477	762	26.5
24	488	778	28.2
25	498	794	30.0
26	508	810	31.8
27	517	825	33.7
28	527	840	35.6
29	536	855	37.5
30	545	870	39 4
31	554	884	41 4
32	563	898	43.4
33	572	912	45.5
34	581	926	47.6
35	589	940	49.7
36	597	953	51.8
37	606	966	54.0
38	614	979	56.2
39	622	992	58.4
40	630	1004	60.7

See page 33 for Table of 12-inch Wheel under heads of 41 to 100 feet.

Digitized by Google

15-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	178	566	4.3
6	195	620	5.6
7	211	670	7.1
8	225	716	8.7
9	239	760	10.3
10	252	801	12.1
11	264	840	14.0
12	276	877	15.9
13	287	913	17.9
14	298	947	20.0
15	308	981	22.2
16	319	1013	24.5
17	328	1044	26.8
18	338	1074	29.2
19	347	1104	31.7
20	356	1132	34.2
21	365	1160	36.8
22	374	1188	39.5
23	382	1214	42.2
24	390	1240	45.0
25	398	1266	47.8
26	406	1291	50.7
27	414	1316	53.7
28	421	1340	56.7
29	429	1364	59.8
30	436	1387	62.9
31	443	1410	66.0
32	451	1432	69.3
33	458	1455	72.5
34	464	1476	75.9
35	471	1498	79.2
36	478	1519	82.6
37	484	1540	86.1
38	491	1561	89.6
39	497	1581	93.2
40	504	1601	96.8

See page 34 for Table of 15-inch Wheel under heads of 41 to 100 feet.

Digitized by Google

18-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	144	828	6.3
6	158	908	8.2
7	170	980	10.4
8	182	1048	12.7
9	193	1111	15.1
10	203	1172	17.7
11	213	1229	20.4
12	223	1283	23.3
13	232	1336	26.2
14	241	1386	29.3
15	249	1435	32.5
16	257	1482	35.8
17	265	1528	39.2
18	273	1572	42.8
19	280	1615	46.4
20	288	1657	50.1
21	295	1698	53.9
22	302	1738	57.8
23	309	1777	61.8
24	315	1815	65.8
25	322	1852	70.0
26	328	1889	74.2
27	334	1925	78.5
28	340	1960	82.9
29	346	1995	87.4
30	352	2029	92.0
31	358	2063	96.6
32	364	2096	101.3
33	370	2128	106.1
34	375	2160	111.0
35	381	2192	115.9
36	386	2223	120.9
37	391	2254	126.0
38	397	2284	131.1
39	402	2314	136.4
40	407	2343	141.6

See page 35 for Table of 18-inch Wheel under heads of 41 to 100 feet.

Digitized by Google

21-INCH WHEEL.

Head	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	137	1172	8.9
6	150	1283	11.6
7	162	1386	14.7
8	173	1482	17.9
9	184	1572	21.4
10	194	1657	25 0
11	203	1738	28.9
12	212	1815	32.9
13	221	1889	37.1
14	229	1960	41.5
15	237	2029	46.0
16	245	2096	50.7
17	253	2160	55.5
18	260	2223	60.5
19	267	2284	65.6
20	274	2343	70.8
21	281	2401	76.2
22	287	2457	81.7
23	294	2513	87.3
24	300	2567	93.1
25	306	2620	99.0
26	312	2672	105.0
27	318	2722	111.1
28	324	2772	117.3
29	330	2821	123.6
30	336	2870	130.1
31	341	2917	136.6
32	347	2964	143.3
33	352	3010	150.1
34	357	3055	157.0
35	362	3100	163.9
36	368	3144	171.0
37	373	3187	178.2
38	378	3230	185.5
39	383	3272	192.8
40	387	3314	200.3

See page 36 for Table of 21-inch Wheel under heads of 41 to 100 feet.

Digitized by Google

24-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	113	1547	11.7
6	124	1695	15.4
7	134	1831	19.4
8	143	1957	23.7
9	152	2076	28.2
10	160	2188	33.1
11	168	2295	38.1
12	175	2397	43.5
13	182	2495	49.0
14	189	2589	54.8
15	196	2680	60.7
16	202	2768	66.9
17	208	2853	73.3
18	214	2936	79.8
19	220	3016	86.6
20	226	3095	93.5
21	232	3171	100.6
22	237	3246	107.9
23	242	3318	115.3
24	248	3390	122.9
25	253	3460	130.7
26	258	3528	138.6
27	263	3595	146.7
28	267	3661	154.9
29	272	3726	163.3
30	277	3790	171.8
31	281	3853	180.5
32	286	3914	189.3
33	290	3975	198.2
34	295	4035	207.3
35	299	4094	216.5
36	303	4152	225.8
37	307	4209	235.3
38	312	4265	244.9
39	316	4321	254.7
40	320	4376	264.5

See page 37 for Table of 24-inch Wheel under heads of 41 to 100 feet.

Digitized by Google

27-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic Feet per Minute.	Horse Power
5	106	1960	14.8
6	116	2147	19.5
7	125	2319	24.5
8	134	2479	30.0
9	142	2629	35.8
10	149	2771	41.9
11	157	2906	48.3
12	164	3036	55.0
13	170	3160	62.1
14	177	3279	69.4
15	183	3394	76.9
16	189	3505	84.7
17	195	3613	92.8
18	200	3718	101.1
19	206	3820	109.7
20	211	3919	118.4
21	217	4016	127.4
22	222	4110	136.6
23	227	4203	146.1
24	231	4293	155.7
25	236	4382	165.5
26	241	4468	175.6
27	245	4554	185.8
28	250	4637	196.2
29	254	4719	206.8
30	259	4800	217.6
31	263	4879	228.6
32	267	4957	239.7
33	271	5034	251.0
34	275	5110	262.5
35	280	5184	274.2
36	283	5258	286.0
37	287	5331	298 0
38	291	5402	310.2
39	295	5473	322.5
40	299	5542	335.0

See page 38 for Table of 27 inch Wheel under heads of 41 to 100 feet.

Digitized by Google

30-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	93	2361	17.8
6	102	2586	23.4
7	110	2793	29.5
8	118	2986	36.1
9	125	3167	43.1
10	132	3338	50.4
11	138	3501	58.2
12	144	3657	66.3
13	150	3806	74.8
14	156	3950	83.6
15	161	4089	92.7
16	167	4223	102.1
17	172	4353	111.8
18	177	4479	121.8
19	182	4602	132.1
20	186	4721	142.7
21	191	4838	153.5
22	195	4952	164.6
23	200	5063	176 0
24	204	5172	187.6
25	208	5278	199.4
26	212	5383	211.5
27	216	5486	223.8
28	220	5586	236.3
29	224	5685	249.1
30	228	5782	262.1
31	232	5878	275.3
32	236	5972	288.8
33	239	6064	302.4
34	243	6156	316.3
35	246	6246	330.3
36	250	6334	344.6
37	253	6421	359.0
38	257	6508	373.7
39	260	6593	388.5
40	263	6677	403.6

See page 39 for Table of 30-inch Wheel under heads of 41 to 100 feet.

Digitized by Google

33-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	81	2888	21.7
6	89	3163	28.7
7	96	3417	36.1
8	102	3653	44.2
9	109	3875	52.6
10	114	4084	61.7
11	120	4284	71.1
12	125	4474	81.1
13	131	4657	91.5
14	135	4833	102.1
15	140	5002	113.4
16	145	5166	124.9
17	149	5326	136.8
18	154	5480	149.0
19	158	5630	161.7
20	162	5777	174.5
21	166	5919	187.8
22	170	6058	201.4
23	174	6195	215.2
24	177	6328	229.4
25	181	6458	243 9
26	185	6586	258 7
27	188	6712	273 7
28	192	6835	288.1
29	195	6956	304.8
30	198	7075	320 7
31	202	7191	336 9
32	205	7307	353.3
33	208	7420	370.0
34	211	7531	386 9
35	214	7641	404.1
36	217	7750	421.6
37	220	7857	439.3
38	223	7962	457 2
39	226	8066	475.4
40	229	8169	493.7

Digitized by Google

36-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	79	3316	25.1
6	87	3632	32.9
7	94	3923	41.5
8	100	4194	50.7
9	106	4449	60.5
10	112	4689	70 9
11	118	4918	81.7
12	123	5137	93.1
13	128	5347	105.0
14	133	5548	117.4
15	137	5743	130.2
16	142	5931	143.4
17	146	6114	157.1
18	150	6291	171.1
19	154	6464	185.6
20	158	6632	200.4
21	162	6795	215.6
22	166	6955	231.2
23	170	7112	247.2
24	174	7265	263.4
25	177	7414	280.1
26	181	7561	297.1
27	184	7705	314.4
28	187	7847	332.0
29	191	7985	349.9
30	194	8122	368.2
31	197	8256	386.7
32	200	8388	405.6
33	204	8518	424.8
34	207	8646	444.2
35	210	8773	464.0
36	213	8897	484.0
37	216	9020	504.3
38	218	9141	524.9
39	221	9260	545.7
40	224	9378	566.9

Digitized by Google

39-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	69	3898	29.4
6	76	4270	38.7
7	82	4612	48.8
8	87	4930	59.6
9	93	5229	71.1
10	98	5512	83.3
11	103	5781	96.1
12	107	6038	109.5
13	111	6285	123.5
14	116	6522	138.0
15	120	6751	153.0
16	124	6972	168.6
17	127	7187	184.6
18	131	7395	201.1
19	135	7598	218.1
20	138	7795	235.6
21	142	7988	253.5
22	145	8176	271.8
23	148	8359	290.5
24	151	8539	309.7
25	155	8715	329.2
26	158	8888	349.2
27	161	9057	369.5
28	164	9223	390.2
29	166	9387	411.3
30	169	9547	432.8
31	172	9705	454.6
32	175	9860	476.8
33	178	10013	499.3
34	180	10164	522.2
35	183	10312	545.4
36	186	10459	568.9
37	188	10603	592.8
38	191	10745	617.0
39	193	10885	641.5
40	196	11024	666.3

Digitized by Google

42-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	67	4786	36.2
6	74	5242	47.5
7	80	5662	59.9
8	85	6053	73.2
9	90	6421	87.3
10	95	6768	102.3
11	100	7098	118.0
12	104	7414	134.4
13	108	7717	151.6
14	112	8008	169.4
15	116	8289	187.9
16	120	8561	207.0
17	124	8824	226.7
18	128	9080	247.0
19	131	9329	267.8
20	134	9571	289.3
21	138	9808	311.2
22	141	10038	333.7
23	144	10264	356.7
24	147	10485	380.2
25	150	10701	404.2
26	153	10913	428.7
27	156	11121	453.7
28	159	11325	479.1
29	162	11525	505.0
30	165	11722	531.4
31	167	11916	558.2
32	170	12107	585.4
33	173	12294	613.1
34	175	12479	641.1
35	178	12661	669.6
36	180	12841	698.5
37	183	13018	727.8
38	185	13193	757.5
39	188	13365	787.6
40	190	13536	818.1

Digitized by Google

45-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	61	5096	38.5
6	67	5582	50.6
7	72	6030	63.8
8	77	6446	77.9
9	82	6837	93.0
10	87	7207	108.9
11	91	7558	125.6
12	95	7894	143.1
13	99	8217	161.4
14	102	8527	180.4
15	106	8826	200.1
16	109	9116	220.4
17	113	9396	241.4
18	116	9669	263.0
19	119	9934	285.2
20	122	10192	308.0
21	125	10443	331.4
22	128	10689	355.3
23	131	10929	379.8
24	134	11164	404.9
25	137	11395	430.5
26	139	11620	456.5
27	142	11842	483.1
28	145	12059	510.2
29	147	12272	537.8
30	150	12482	565.8
31	152	12689	594.4
32	155	12892	623.4
33	157	13091	652.8
34	160	13288	682.7
35	162	13482	713.0
36	164	13674	743.8
37	166	13862	775.2
38	169	14048	806.7
39	171	14232	838.7
40	173	14413	871.2

Digitized by Google

48-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	55	5749	43.4
6	60	6298	57.1
7	65	6802	72.0
8	70	7272	87.9
9	74	7713	104.9
10	78	8130	122.9
11	82	8527	141.7
12	85	8906	161.5
13	89	9270	182.1
14	92	9620	203.5
15	95	9958	225.7
16	98	10284	248.6
17	101	10601	272.4
18	104	10908	296.7
19	107	11207	321.8
20	110	11498	347 5
21	113	11782	373.9
22	115	12059	400.9
23	118	12330	428 5
24	121	12595	456.8
25	123	12855	485.6
26	126	13110	515.0
27	128	13360	545.0
28	130	13605	575.6
29	133	13845	606.7
30	135	14082	638.4
31	137	14315	670.6
32	139	14544	703.3
33	141	14769	736.5
34	144	14992	770.2
35	146	15210	804.4
36	148	15426	839.2
37	150	15639	874.4
38	152	15849	910.0
39	154	16056	946.2
40	156	16261	982.8

Digitized by Google

51-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
5	56	6545	49.5
6	61	7170	65.0
7	66	7745	81.9
8	70	8279	100.1
9	75	8782	119.4
10	79	9257	139.9
11	82	9708	161.4
12	86	10140	183.9
13	90	10554	207.3
14	93	10952	231.7
15	96	11337	257.0
16	99	11709	283.1
17	103	12069	310.0
18	106	12419	337.8
19	108	12759	366.3
20	111	13091	395 6
21	114	13414	425.7
22	117	13730	456.4
23	119	14038	487.9
24	122	14340	520.0
25	124	14636	552.9
26	127	14926	586.4
27	129	15210	620.5
28	132	15489	655.3
29	134	15763	690.8
30	136	16033	726.8
31	138	16298	763.4
32	141	16559	800.7
33	143	16815	838.5
34	145	17068	876.9
35	147	17317	915.9
36	149	17563	955.4
37	151	17805	995.5
38	153	18044	1036.1
39	155	18280	1077.3
40	157	18513	1119.0

Digitized by Google

54-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic Feet per Minute.	Horse Power.
5	51	7707	58.2
6	56	8449	76.5
7	60	9119	96.5
8	64	9748	117.8
9	68	10340	140.6
10	72	10899	164.7
11	76	11431	190.0
12	79	11939	216.5
13	82	12427	244.0
14	85	12896	272.8
15	88	13348	302.6
16	91	13786	333.3
17	94	14210	365.0
18	97	14622	397.7
19	99	15023	431.3
20	102	15413	465.8
21	105	15794	501.2
22	107	16166	537.4
23	109	16529	574.5
24	112	16885	612.3
25	114	17233	651.0
26	116	17574	690.4
27	119	17909	730.7
28	121	18237	771.6
29	123	18560	813.3
30	125	18878	855.7
31	127	19190	898.9
32	129	19497	942.7
33	131	19799	987.3
34	133	20097	1032.5
35	135	20390	1078.4
36	137	20679	1124.9
37	139	20965	1172.1
38	141	21246	1219.9
39	142	21524	1268.4
40	144	21798	1317.5

Digitized by Google

57-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic Feet per Minute.	Horse Power.
5	50	8646	65.3
6	55	9472	85.9
7	59	10231	108.2
8	63	10937	132.2
9	67	11601	157.8
10	70	12228	184.8
11	74	12825	213.2
12	77	13395	242.9
13	80	13942	273.9
14	83	14468	300.1
15	86	14976	330.4
16	89	15467	374.0
17	92	15943	409.6
18	94	16406	446.2
19	97	16855	483.9
20	100	17293	522.6
21	102	17720	562 3
22	104	18137	602.9
23	107	18545	644.5
24	109	18944	687.0
25	111	19334	730.4
26	113	19717	774.6
27	116	20093	819.7
28	118	20461	865.7
29	120	20824	912.5
30	122	21179	960.1
31	124	21530	1008.5
32	126	21874	1057.7
33	128	22213	1107.6
34	130	22547	1158.4
35	132	22876	1209.9
36	134	23201	1262.1
37	135	23521	1315.0
38	137	23837	1368.7
39	139	24148	1423.1
40	141	24456	1478.2

Digitized by Google

60-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic Feet per Minute.	Horse Power.
4	42	9723	58.7
5	46	10870	82.2
6	50	11908	108.0
7	54	12862	136.0
8	58	13740	165.8
9	62	14584	198.3
10	65	15374	232.3
11	68	16124	267.9
12	71	16842	305.4
13	74	17529	344.2
14	77	18210	384.8
15	79	18829	426.8
16	82	19447	470.1
17	85	20044	514.9
18	87	20625	561.0
19	89	21192	608.4
20	92	21741	657.1
21	94	22279	706.9
22	96	22803	758.0
23	98	23316	810.3
24	100	23817	863.7
25	103	24308	918.2
26	105	24789	973.9
27	107	25262	1030.6
28	109	25725	1087.4
29	111	26181	1147.3
30	112	26629	1207.0
31	114	27068	1268.0
32	116	27501	1329.8
33	118	27928	1392.6
34	120	28318	1456.4
35	121	28762	1521.1
36	123	29170	1586.7
37	125	29573	1653.3
38	127	29970	1720.9
39	128	30361	1789.2
40	130	30748	1858.4

Digitized by Google

66-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic Feet per Minute.	Horse Power.
4	38	11765	71.1
5	42	13154	99.3
6	46	14409	130.6
7	49	15564	164.6
8	53	16669	201.1
9	56	17648	240.0
10	59	18602	281 0
11	62	19510	324.2
12	65	20378	369.4
13	67	21210	416.6
14	70	22011	465.6
15	72	22783	516.3
16	75	23530	568.9
17	77	24255	623.0
18	79	24957	678.8
19	81	25641	736.2
20	83	26308	795.1
21	86	26958	855.4
22	88	27592	917.2
23	89	28212	980.5
24	91	28819	1045.0
25	93	29413	1111.0
26	95	29996	1178.5
27	97	30567	1247.1
28	99	31128	1317.0
29	100	31678	1388.1
30	102	32221	1460.6
31	104	32753	1534.2
32	106	33277	1609.0
33	107	33793	1685.1
34	109	34297	1762.3
35	110	34802	1860.6
36	112	35296	1920.0
37	113	35782	2000.6
38	115	36264	2082.2
39	117	36738	2164.9
40	118	37206	2248.8

Digitized by Google

72-INCH WHEEL.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
4	37	14796	89.3
5	41	16546	113.5
6	48	18119	164.2
7	49	19580	205.3
8	52	20931	252 9
9	56	22194	301.7
10	59	23412	354.6
11	61	24542	407.9
12	64	25627	464.6
13	67	26690	524.2
14	70	27687	586.4
15	72	28662	649 6
16	74	29614	716.0
17	77	30522	759.7
18	79	31408	854.2
19	81	32272	902.3
20	83	33114	1000.7
21	85	33911	1076 0
22	88	34709	1153.8
23	90	35484	1233.2
24	91	36259	1314.9
25	93	37012	1398 4
26	94	37743	1482.8
27	96	38452	1568.8
28	99	39161	1656.8
29	100	39847	1748.5
30	102	40534	1821.5
31	104	41199	1929 9
32	105	41863	2024.7
33	107	42528	2120.7
34	108	43170	2217.9
35	110	43790	2318.4
36	112	44410	2415 8
37	113	45030	2517.6
38	114	45629	2620.0
39	116	46227	2726 9
40	117	46802	28.8.8

Digitized by Google

9-INCH WHEEL.

(*Continued from page 12.*)

Head.	Revolutions per Minute.	Discharge. Cubic Feet Per Minute.	Horse Power.
41	850	584	36.2
42	860	591	37.5
43	870	598	38.8
44	881	605	40.2
45	891	612	41.6
46	900	618	43.0
47	910	625	44.4
48	920	632	45.8
49	929	638	47.2
50	939	645	48.7
52	957	657	51.7
54	976	670	54.7
56	993	682	57.7
58	1011	694	60.8
60	1028	706	64.0
62	1045	718	67.2
64	1062	729	70.5
66	1078	741	73.9
68	1095	752	77.2
70	1111	763	80.7
72	1126	773	84.2
74	1142	784	87.7
76	1157	795	91 3
78	1172	805	94.9
80	1187	815	98.6
85	1224	840	107.9
90	1259	865	117.6
95	1294	888	127.5
100	1327	912	137.7

Digitized by Google

12-INCH WHEEL.

(Continued from page 13.)

Head.	Revolutions per Minute.	Discharge. Cubic Feet per Minute.	Horse Power.
41	638	1017	63.0
42	645	1029	65.3
43	653	1041	67.7
44	660	1053	70.0
45	668	1065	72.4
46	675	1077	74.9
47	683	1089	77.3
48	690	1100	79.8
49	697	1112	82.3
50	704	1123	84.8
52	718	1145	90.0
54	732	1167	95.2
56	745	1188	100.6
58	758	1210	106.0
60	771	1230	111.5
62	784	1251	117.2
64	796	1271	122.9
66	809	1290	128.7
68	821	1310	134.6
70	833	1329	140.5
72	845	1348	146.6
74	856	1366	152.8
76	868	1385	159.0
78	879	1403	165.3
80	891	1420	171.7
85	918	1464	188.1
90	945	1507	204.9
95	970	1548	222.2
100	996	1588	240.0

Digitized by Google

15-INCH WHEEL.

Continued from page 14.

Head.	Revolutions per Minute.	Discharge. Cubic feet per Minute.	Horse Power.
41	510	1621	100.4
42	516	1641	104.1
43	522	1660	107.9
44	528	1680	111.7
45	534	1698	115.5
46	540	1716	119.4
47	546	1734	123.3
48	552	1754	127.2
49	558	1772	131.2
50	563	1808	135.3
52	574	1826	143.5
54	585	1842	151.8
56	596	1894	160.3
58	607	1910	169.0
60	617	1961	177.8
62	627	1994	186.8
64	637	2026	195.9
66	647	2057	205.2
68	657	2088	214.6
70	666	2119	224.1
72	676	2149	233.8
74	685	2178	243.6
76	694	2207	253.5
78	703	2236	263.6
80	712	2265	273.8
85	734	2335	299.8
90	756	2402	326.7
95	776	2468	354.3
100	796	2532	382.6

Digitized by Google

18-INCH WHEEL.

Continued from page 15.

Head.	Revolutions per Minute.	Discharge. Cubic Feet per Minute.	Horse Power.
41	412	2372	147.0
42	417	2401	152.4
43	422	2430	157 9
44	427	2458	163 4
45	432	2485	169 0
46	436	2513	174.7
47	441	2540	180 4
48	446	2567	186.2
49	450	2593	192.0
50	455	2620	197.9
52	464	2672	209 9
54	473	2723	222 2
56	481	2773	234 6
58	490	2822	247 3
60	498	2870	260.2
62	507	2917	273.3
64	515	2964	286.6
66	523	3010	300.2
68	530	3055	313 9
70	538	3100	327.9
72	546	3144	342.0
74	553	3187	356.4
76	561	3230	370.9
78	568	3272	385.7
80	575	3314	400.6
85	593	3416	438.7
90	610	3515	478.0
95	627	3611	518.4
100	643	3705	559.8

Digitized by Google

21-INCH WHEEL.

(*Continued from page 16.*)

Head.	Revolutions per Minute.	Discharge. Cubic Feet per Minute.	Horse Power.
41	392	3355	207.8
42	397	3396	215 5
43	402	3436	223 2
44	406	3475	231.1
45	411	3515	239.0
46	416	3554	247.0
47	420	3592	255.1
48	424	3630	263.3
49	429	3668	271.6
50	433	3705	279.9
52	442	3778	296.9
54	450	3850	314.2
56	458	3921	331.8
58	467	3990	349.7
60	475	4058	367 9
62	482	4125	386.5
64	490	4192	405.3
66	498	4256	424.5
68	505	4320	443.9
70	513	4384	463.7
72	520	4446	483.7
74	527	4507	504.0
76	534	4568	524.5
78	541	4627	545.4
80	548	4686	566.5
85	565	4830	620.4
90	581	4971	676.0
95	597	5107	733.1
100	613	5239	791.7

Digitized by Google

24-INCH WHEEL.

(*Continued from page 17.*)

Head.	Revolutions per Minute.	Discharge. Cubic Feet per Minute.	Horse Power.
41	324	4431	274.5
42	328	4484	284.6
43	331	4537	294.8
44	335	4590	305.2
45	339	4642	315.6
46	343	4693	326.2
47	347	4744	336.9
48	350	4794	347.7
49	354	4844	358.6
50	357	4893	369.7
52	364	4990	392.1
54	371	5085	414.9
56	378	5178	438.2
58	385	5270	461.8
60	392	5360	485.9
62	398	5448	510.4
64	404	5536	535.3
66	411	5621	560.6
68	417	5706	586.3
70	423	5789	612.4
72	429	5871	638.8
74	435	5952	665.6
76	441	6032	692.8
78	446	6111	720.3
80	452	6189	748.1
85	466	6379	819.4
90	480	6564	892.7
95	493	6744	968.2
100	505	6920	1045.6

Digitized by Google

27-INCH WHEEL.

Continued from page 18.

Head.	Revolutions per Minute.	Discharge Cubic Feet per Minute.	Horse Power.
41	302	5611	347 6
42	306	5679	360.4
43	310	5746	373 4
44	313	5813	386 5
45	317	5879	399 7
46	320	5944	413 1
47	324	6008	426.7
48	327	6071	440.4
49	331	6134	454.2
50	334	6197	468 2
52	341	6319	496 5
54	347	6440	525 5
56	354	6558	554 9
58	360	6674	584 9
60	366	6788	615.4
62	372	6900	646 5
64	378	7011	678 0
66	384	7119	710.0
68	390	7226	742 5
70	395	7332	775 5
72	401	7436	809.0
74	406	7538	842 9
76	412	7640	877 3
78	417	7740	912 2
80	423	7838	947.5
85	436	8079	1038 0
90	448	8314	1131 0
95	460	8541	1226 0
100	472	8763	1324.0

Digitized by Google

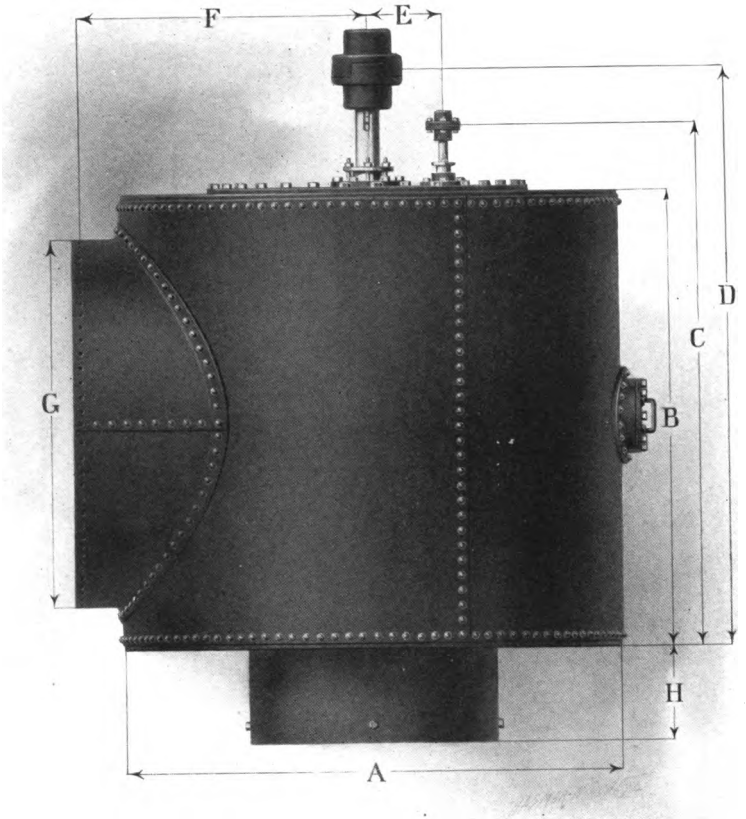
30-INCH WHEEL.

(Continued from page 19.)

Head.	Revolutions per Minute	Discharge Cubic Feet per Minute.	Horse Power
41	267	6760	418.8
42	270	6842	434.2
43	273	6923	449.8
44	277	7003	465.6
45	280	7082	481.5
46	283	7160	497.7
47	286	7237	514.0
48	289	7314	530.5
49	292	7390	547 2
50	295	7465	564 0
52	300	7613	598.2
54	306	7758	633 0
56	312	7900	668.5
58	317	8040	704.6
60	323	8177	741.4
62	328	8312	778.8
64	333	8445	816.7
66	338	8576	855.3
68	344	8705	894.5
70	349	8833	934.2
72	354	8958	974 6
74	358	9081	1015.0
76	363	9203	1057.0
78	368	9324	1099 0
80	373	9442	1141.0
85	384	9733	1250.0
90	395	10015	1362.0
95	406	10289	1477.0
100	417	10557	1595 0

Digitized by Google

IRON FLUMES FOR WATER WHEELS.



ENGRAVING No. 3.

The price of iron flumes usually exceeds the cost of those constructed from wood, but for many locations they are more desirable on account of their durability and freedom from leakeage.

Each flume has a heavy cast iron top and bottom. The top is provided with a lid of sufficient size to admit the wheel and contains packing boxes for wheel and gate shafts.

A man door is conveniently located on the side of the flume affording easy access to the water wheel. See dimensions of flumes on page 41.

Digitized by Google

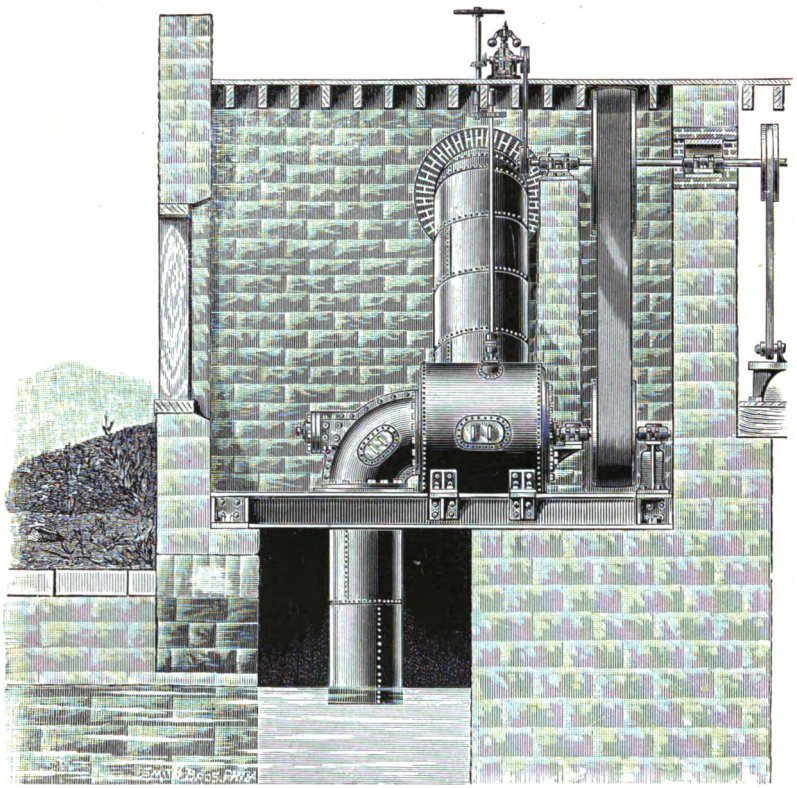
DIMENSIONS

Of Iron Flumes in Inches.

Lettered columns correspond with letters in Engraving No. 3.

Diameter of Wheel.	A	B	C	D	E	F	G	H
9	36	36		57 ½	Dimensions given upon application.	24	24	6 ¼
12	42	42		64 ½		27	30	7 ⅝
15	48	48		70 ½		30	36	9 ⅜
18	54	54	69 ½	76 ½		33	42	10 ½
21	60	60	75 ½	83		38	48	12 ⅜
24	72	70	85 ½	93		44	54	13 ¾
27	84	76	91 ½	99		50	60	15 ½
30	90	82	97 ½	106 ¾		53	66	16 ⅞
33	96	90	108 ½	119		56	72	18 ⅜
36	102	96	114 ½	125		59	78	21 ⅞
39	108	102	120 ½	128 ½		62	84	22 ¾
42	114	108	126 ½	137 ½		65	90	25 ¼
45	120	112	130 ½	142 ½		68	94	26 ⅝
48	126	114	132 ½	144 ½		71	96	28 ⅛
51	132	118	139 ½	152 ½		74	100	29 ¾
54	144	122	144	156 ½		80	104	21 ⅝
57	156	126	148	161 ¾		86	108	33 ⅛
60	168	132	154	167 ¾		92	114	35
66	180	138	160	173 ¾		98	120	41
72	200	162	184	197 ¾		108	144	46 ¾

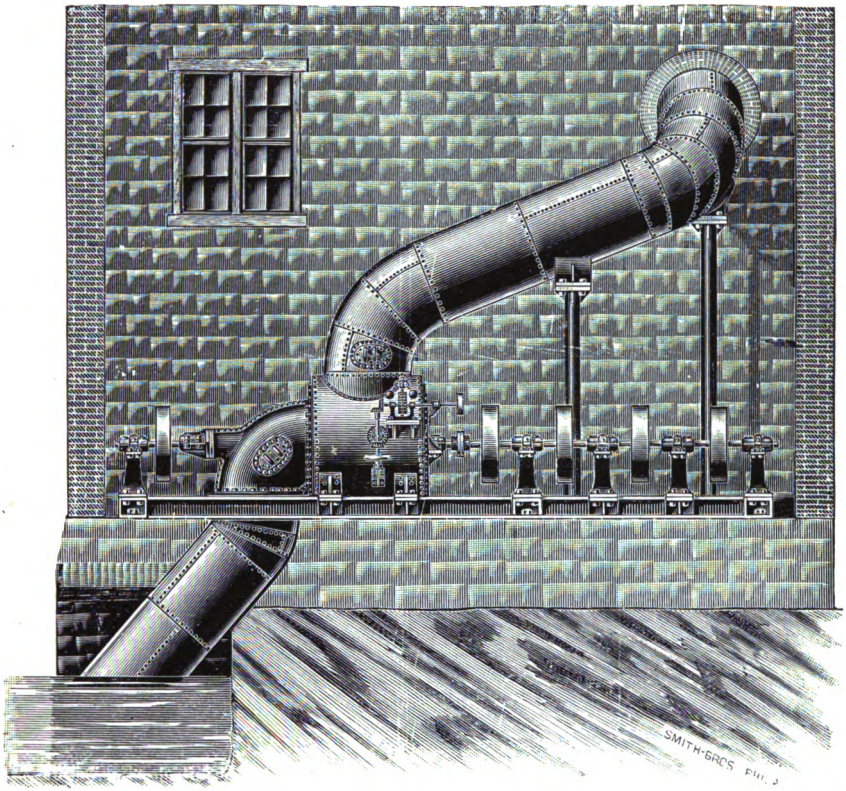
Digitized by Google



ENGRAVING No. 4.

Single 24-inch horizontal shaft Turbine working under 43 feet head, developing 295 horse power, being one of three wheels furnished a prominent manufacturing company in the North. The work is of a substantial character. We have furnished a great many single horizontal Turbines to work under high and low heads, driving electric light plants and various kinds of factories, all of which are giving entire satisfaction. Wherever it is practicable to use horizontal wheels, we advise them, and especially if the wheels are to develop much power.

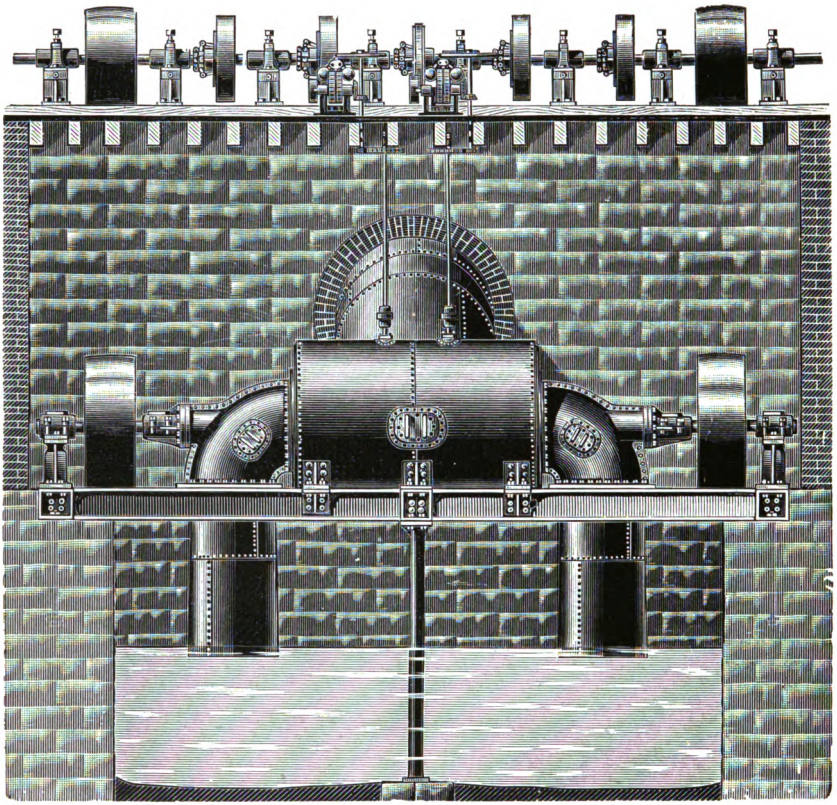
Digitized by Google



ENGRAVING No. 5.

Single 39-inch horizontal shaft Turbine in iron case, working under 39 feet head, developing 642 horse power. The location was a peculiar one, as the construction of the supply pipe and draft-tube indicate. On the wheel shaft are four 60 x 24 and one 60 x 26-inch driving pulleys by which the power is transmitted to the line shafts on three floors of the mill. The entire work is of a substantial character. Our facilities for supplying heavy power transmitting machinery are not surpassed by those of any other water wheel manufacturer. We make a specialty of this class of work and are able to accommodate our customers at reasonable prices.

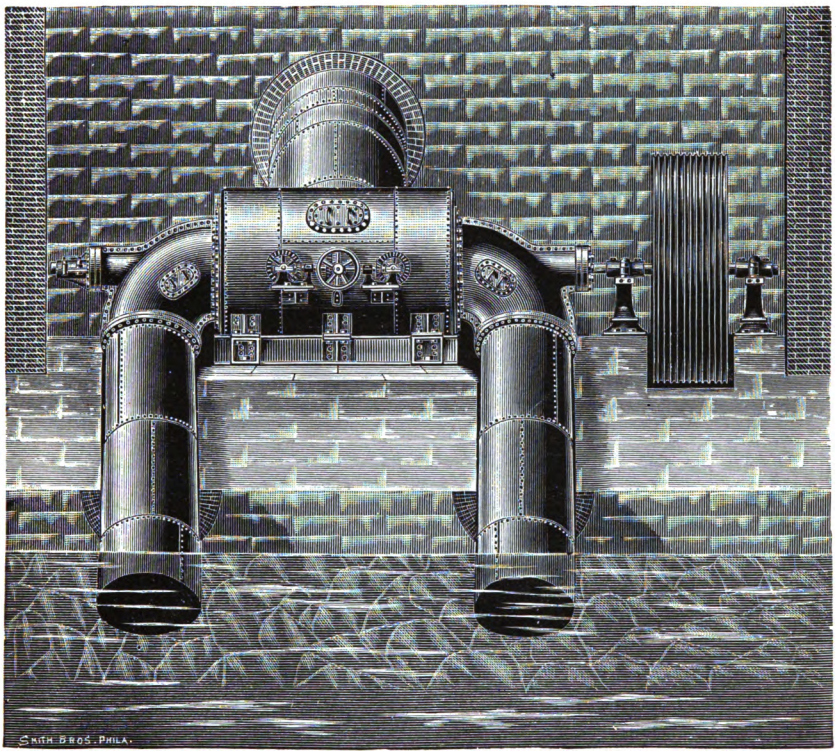
Digitized by Google



ENGRAVING No. 6.

Pair of 27-inch double discharge horizontal shaft Turbines substantially mounted on iron beams, developing 435 horse power under 30 feet head driving an electric light plant. The wheels are arranged with separate gate rigs and can be run separately or together, as work demands. Our Turbines have no equal for driving electrical machinery, and especially Street Railway plants. The balanced cylinder gate and the method of operating same, give it advantages over all other makes.

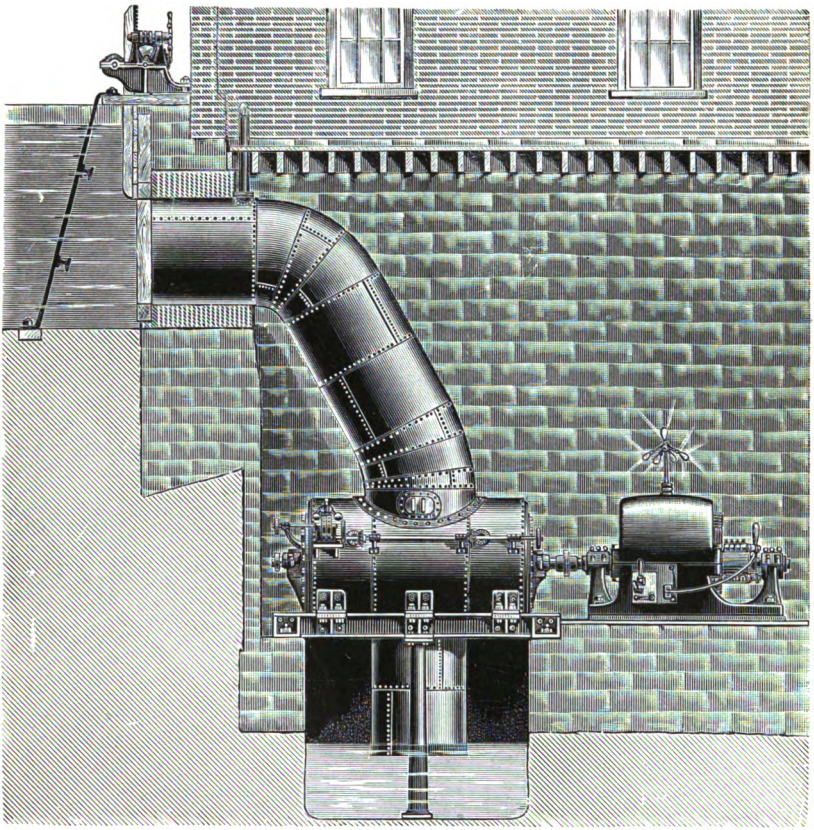
Digitized by Google



ENGRAVING No. 7.

Pair of 42-inch double discharge horizontal shaft Turbines working under 24 feet head, developing 760 horse power in a cotton mill. The draft-tubes pass through the side of the mill wall at an angle of about 30 degrees and discharge into the river. There are many places where much expensive excavation can be saved by placing draft-tubes at an angle.

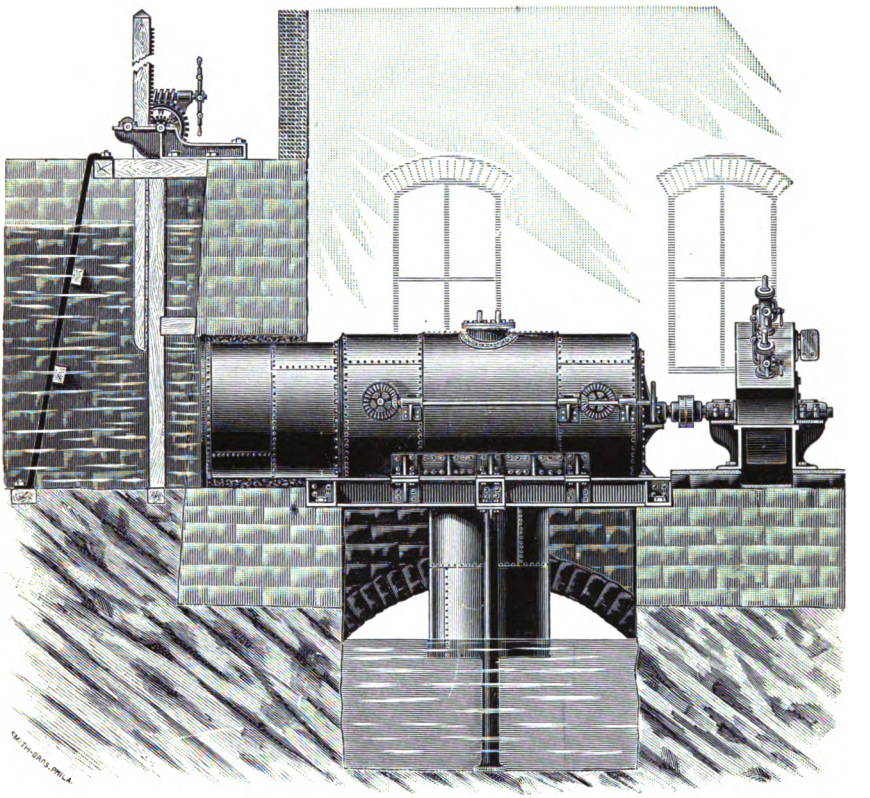
Digitized by Google



ENGRAVING No. 8.

Pair of central discharge 33-inch Turbines in iron flume on horizontal shaft, developing 1500 horse power, connected direct to electric generator. Our Turbines, owing to their enormous capacity and high speed, are especially adapted for driving electrical machinery. Where the location admits, we recommend the connecting of generator direct to wheel shaft, thus dispensing with pulleys and belts, and insuring a more positive and reliable drive.

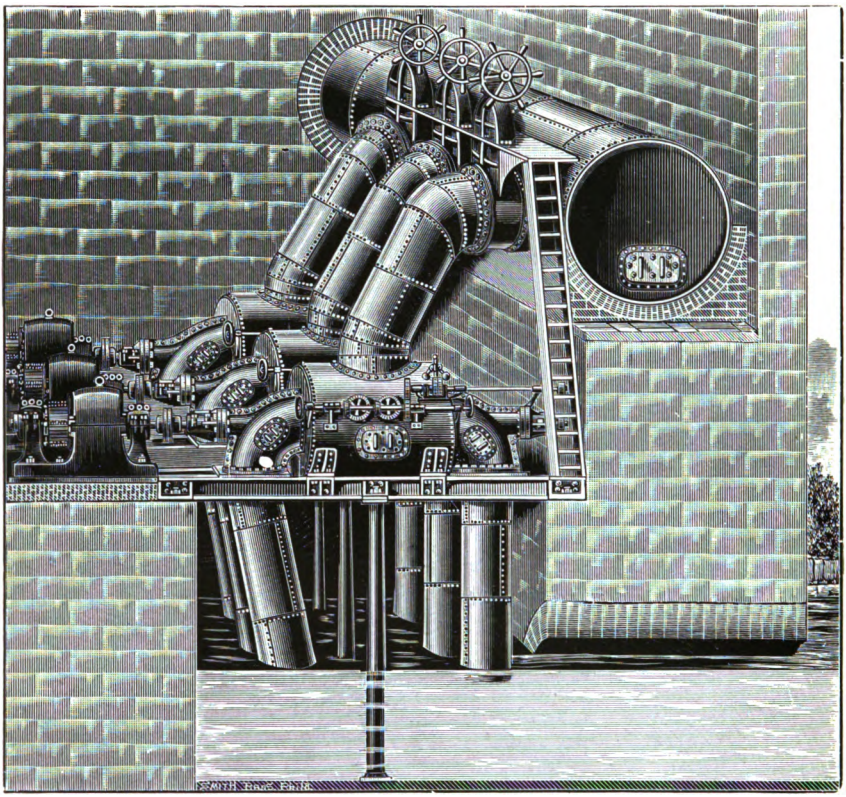
Digitized by Google



ENGRAVING No. 9.

Pair of central discharge 30-inch horizontal shaft Turbines developing 400 horse power under 25 feet head, connected direct to wood pulp grinder, all mounted in a very substantial manner. Water is supplied through an iron pipe at one end of the wheel case. Owing to the great power required for driving pulp grinders, it is advisable, where location will permit, to connect them direct to the water wheel shaft, thus dispensing with gearing. We recently supplied a party, who are large manufacturers of wood pulp, with a pair of 39-inch wheels mounted similar to above engraving. These wheels are developing, 1332 horse power under 40 feet head.

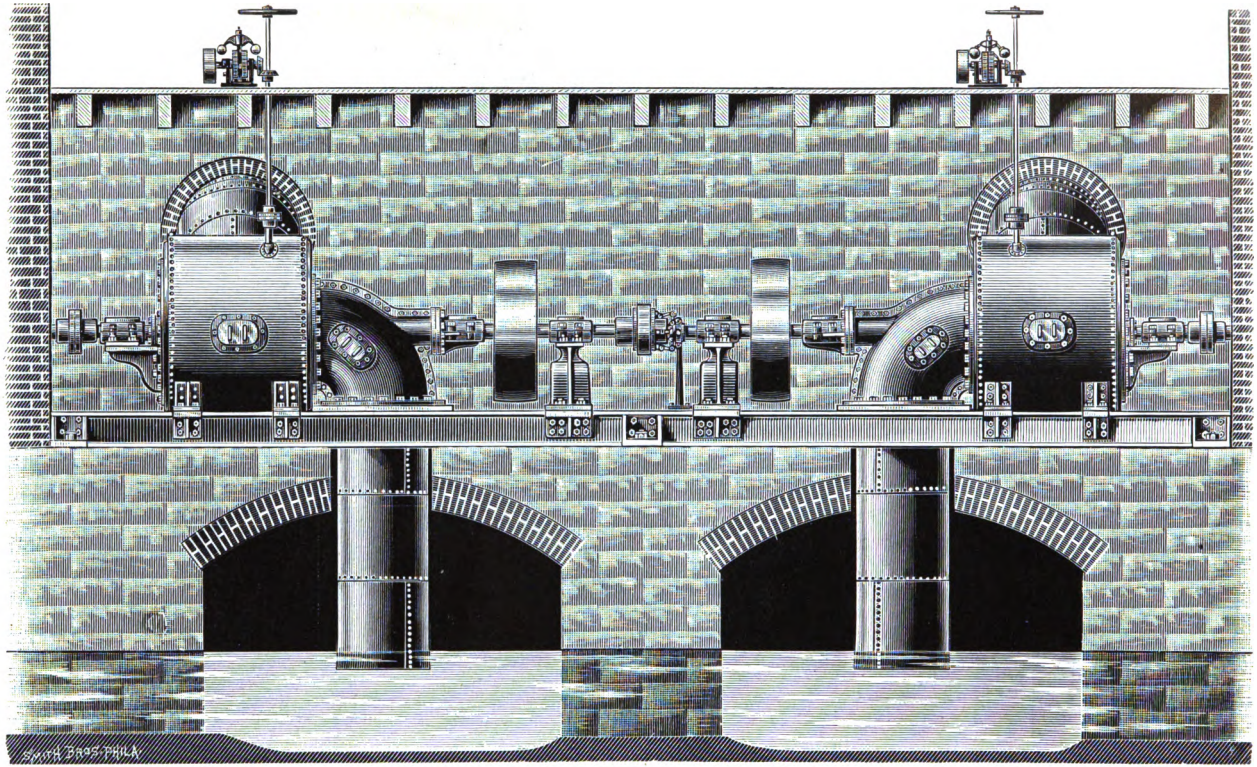
Digitized by Google



ENGRAVING No. 10.

Three pairs of 21-inch horizontal shaft Turbines working under 50 feet head developing 1680 horse power, driving an electric light plant in South America. The water is brought to the power house through a large supply pipe, from which it passes to the wheels through short feeders each having a valve near the main pipe to admit of the closing off of the water from either pair of wheels without disturbing the others. The balanced cylinder gate of this Turbine and the method of operating same, secures closer regulation than can be obtained from any other Turbine. Those intending to drive electrical machinery by water power will find this feature of great value.

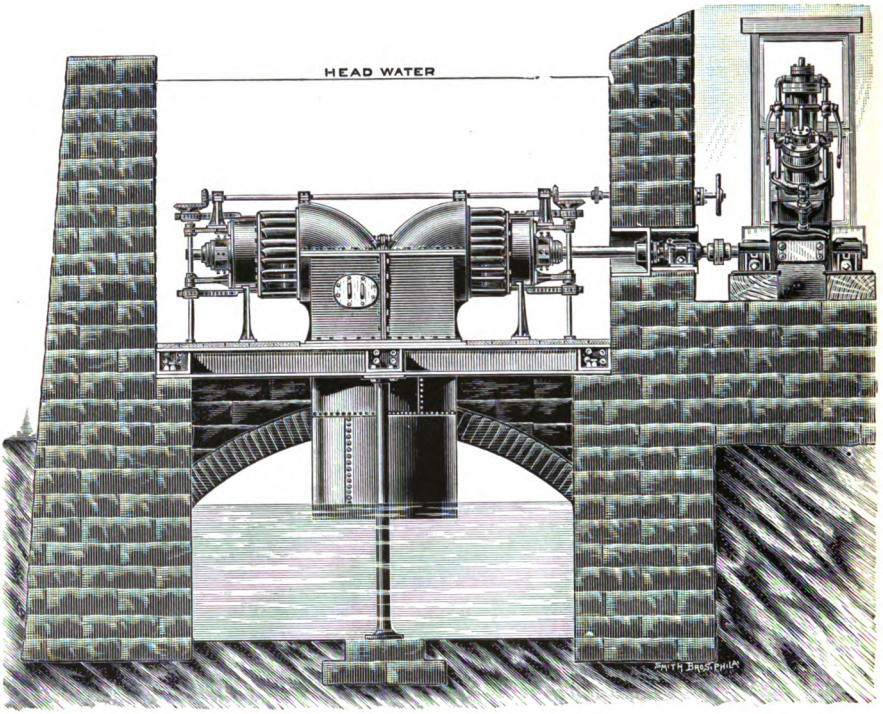
Digitized by Google



ENGRAVING No. 11.

Two single 27-inch horizontal Shaft Turbines under 35 feet head, developing 548 horse power. The wheels are coupled direct to line shaft in a large paper mill, from which the engines and other machinery are driven. The wheels are located in the middle of the building and are connected by a friction cut-off coupling, so they can be run together or independent as may be preferred.

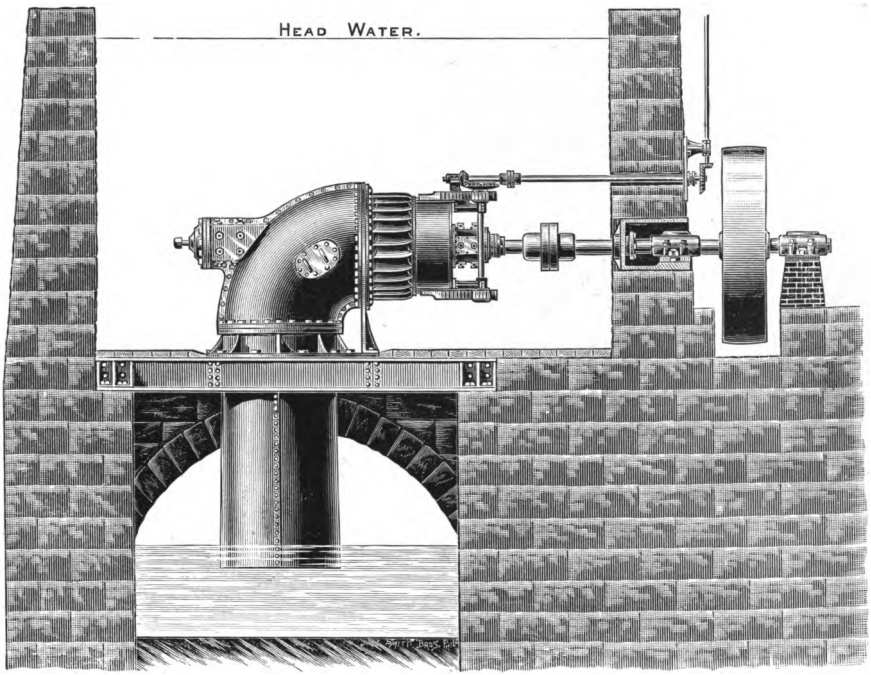
Digitized by Google



ENGRAVING No. 12.

Pair of 36-inch horizontal shaft Turbines mounted on cast iron draft-box, set in open flume, working under 22 feet head developing 462 horse power, and coupled direct to shaft of pulp grinder. We have furnished a great many wheels similar to this engraving arranged to work in stone and wood flumes. In a number of instances where the heads were low and sufficient power and speed could not be obtained from one pair of wheels, we have furnished four wheels coupled together, working in pairs, similar to engraving No. 25. When two pairs of wheels are coupled together on the same shaft, it is highly essential that the foundations be constructed in the most substantial manner.

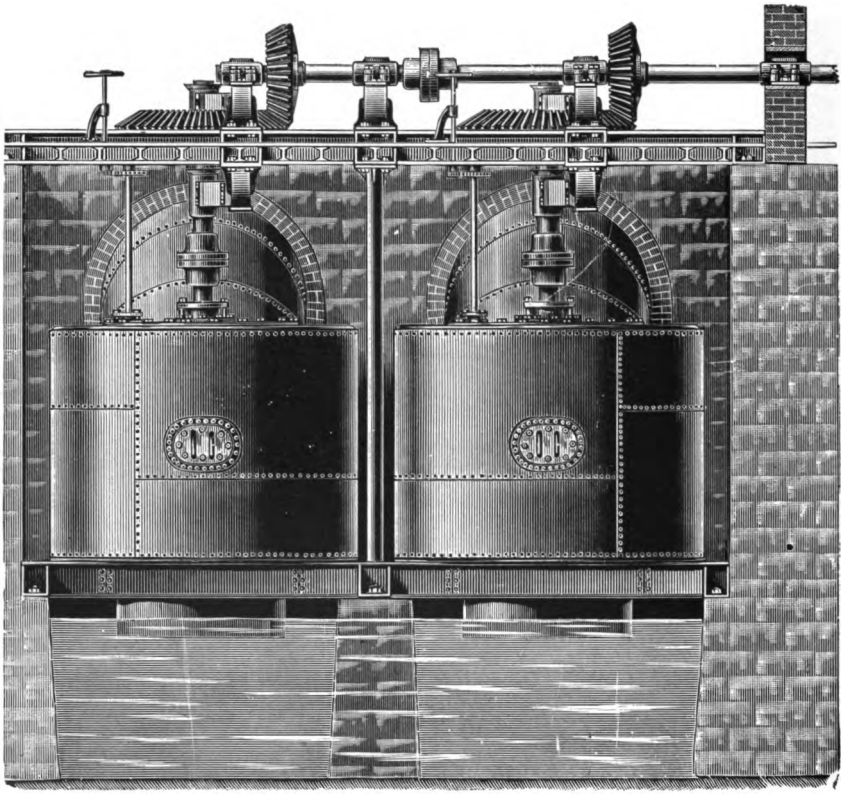
Digitized by Google



ENGRAVING No. 13.

Single 27-inch horizontal shaft Turbine mounted on cast iron elbow set in an open flume under 26 feet head developing 175 horse power. Single horizontal wheels run equally as well as wheels placed in pairs. We have single horizontal wheels in operation developing as much as 2,000 horse power each. Single wheels do not cost as much per horse power as double wheels and for this reason are often preferred. The wheels can be set in wood flumes with as good results as if set in stone flumes

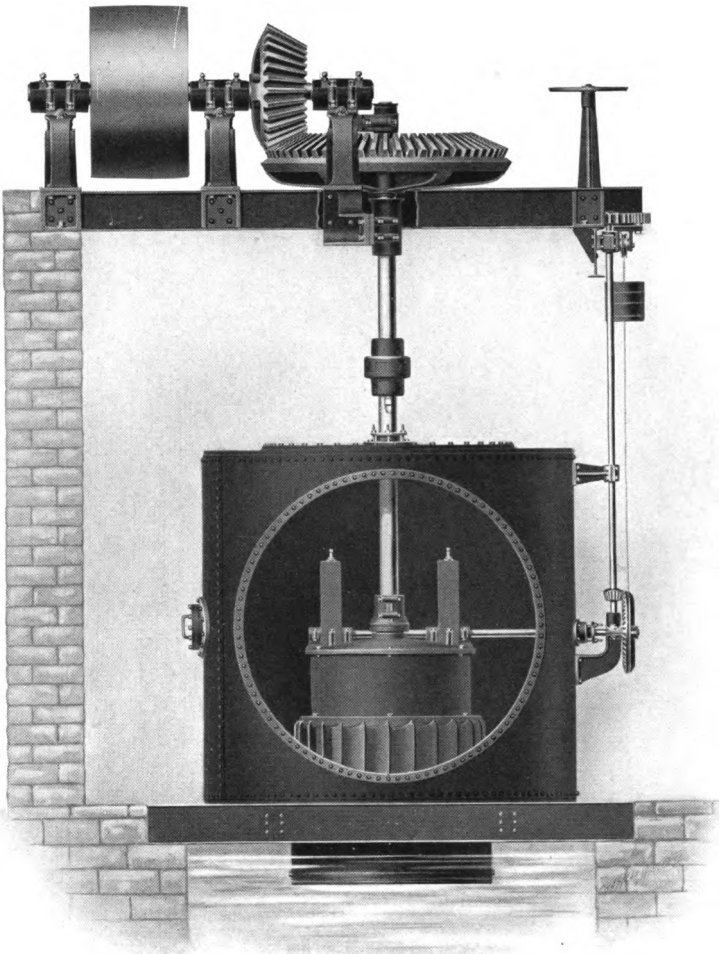
Digitized by Google



ENGRAVING No. 14.

Two 57-inch vertical shaft Turbines in iron cases working under 15 feet head developing 660 horse power. These wheels and machinery were furnished The Syms & Dudley Paper Co., Watervliet, Mich. The work is very heavy, the cases being 14 feet diameter, 10 feet high. Our facilities for building heavy work are unsurpassed. Our large new shops are equipped with machinery especially adapted for the class of work we are doing and we are prepared to contract for wheels and machinery at the lowest prices consistent with good work and material.

Digitized by Google



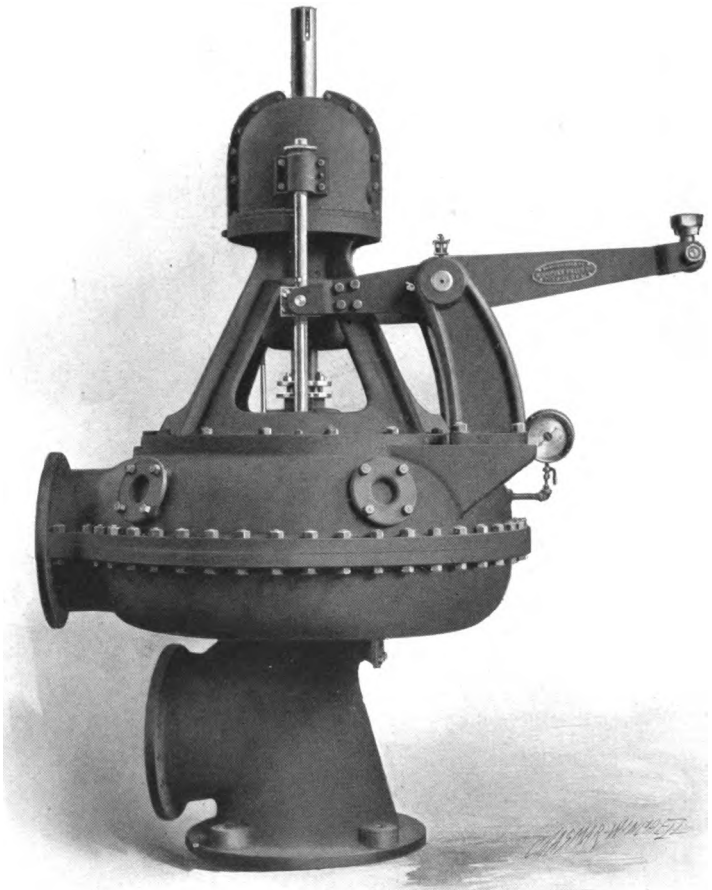
ENGRAVING No. 15.

This represents an ideal setting for vertical shaft water wheels in outer iron cases.

The manner of supporting gears, pulley, horizontal and vertical shafts is of most substantial construction and modern in every respect.

When desired and the location will permit, we can place all the gate gearing including racks and pinions on the outside of case, thereby removing all wearing parts from the water.

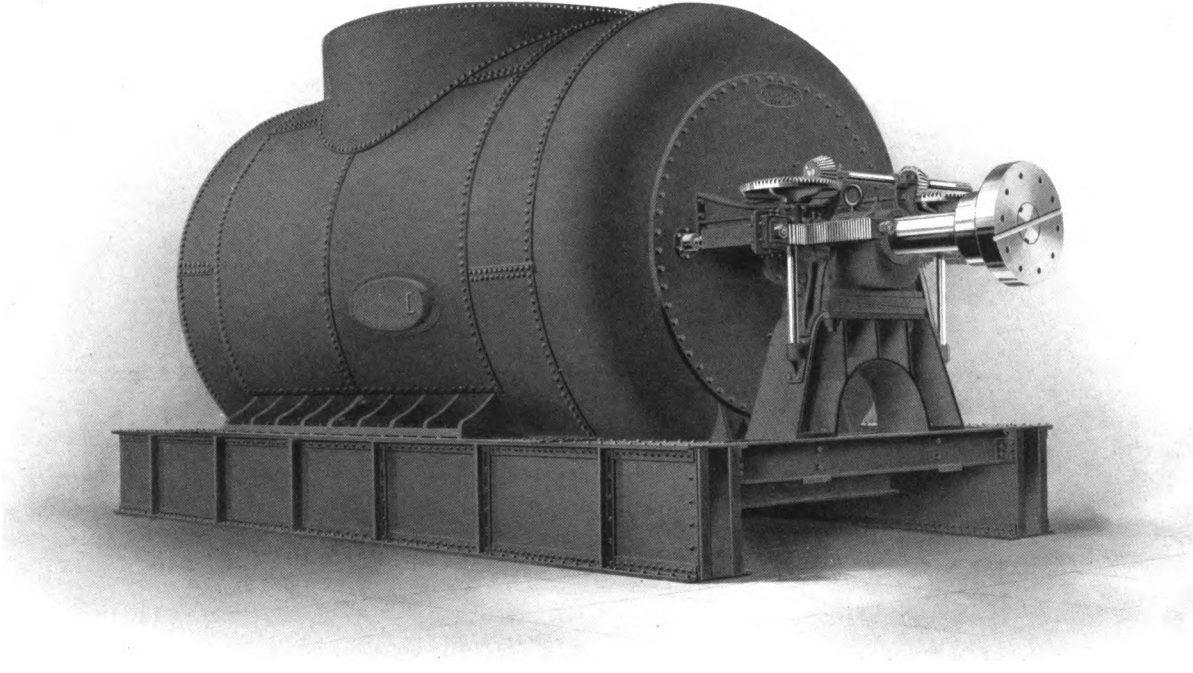
Digitized by Google



ENGRAVING No. 16.

Special vertical shaft cylinder gate turbine driving generator at 750 revolutions with 150 feet head. Four settings like this are operating in the No. 2 plant of the Niagara Falls Power Co., Niagara Falls, N. Y. We also built four settings which have been operating six years in their No. 1 plant.

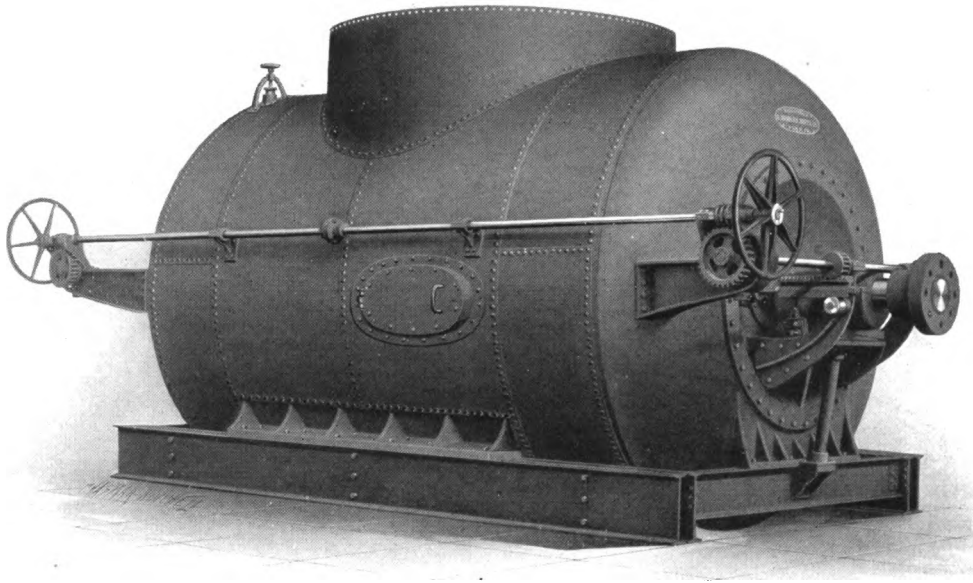
Digitized by Google



ENGRAVING No. 17.

Pair Cylinder Gate Turbines developing 5200 horse power. Five pairs of these Turbines and two pairs each developing 4000 horse power are driving generators and three single wheels driving exciters. Built for the "Spiers Falls Plant" of the Hudson River Water Power Co., Glens Falls, N. Y.

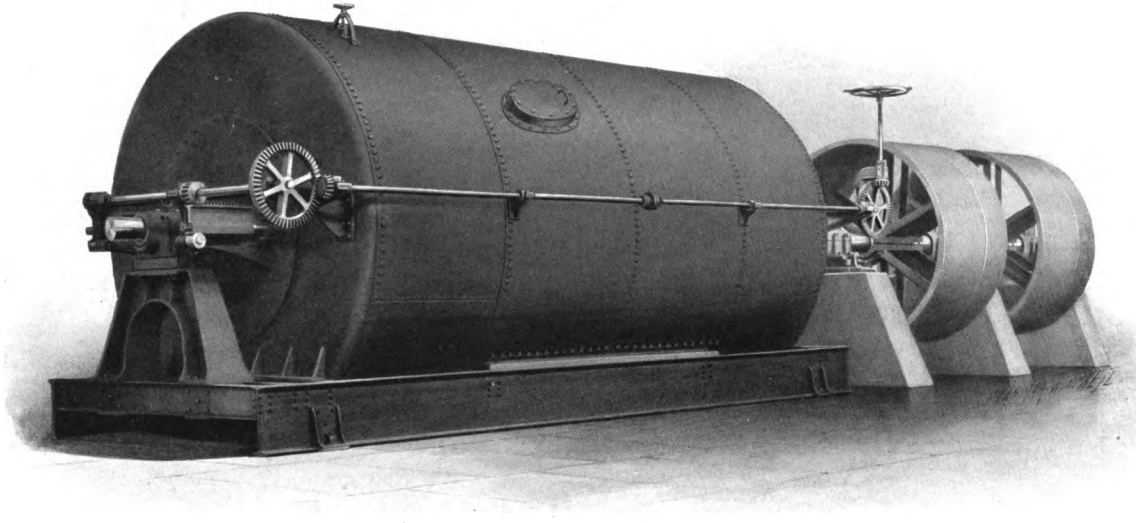
Digitized by Google



ENGRAVING No. 18.

Pair 39-inch Turbines developing 1865 horse power with 50 feet head. Two of these settings and six mounted in a similar manner developing 1100 horse power per pair with 34 feet head, two pairs 36-inch each developing 1500 horse power; also two single 33-inch each developing 1500 horse power with 84 feet head and one of 600 horse power making a total of 17000 horse power used at the International Paper Company's Pulp Mill, Palmer, N. Y

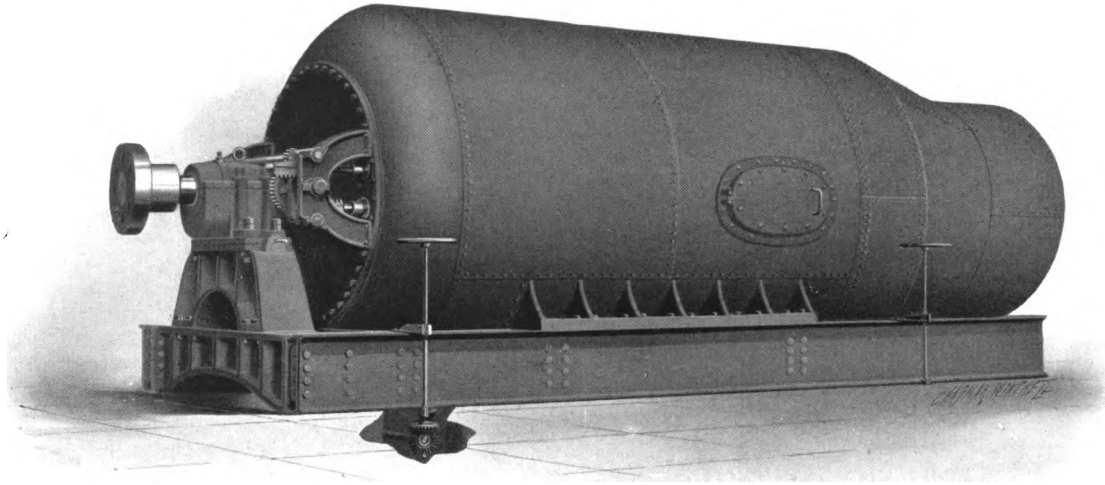
Digitized by Google



ENGRAVING No. 19.

Pair 54-inch turbines, driving machinery in cotton factory of Washington Mills Co., Fries, Grayson Country, Va. Head, 37 feet; 2600 horse-power; 160 revolutions. We furnished them all of the machinery, head-gate irons and supply pipes necessary for a complete power plant.

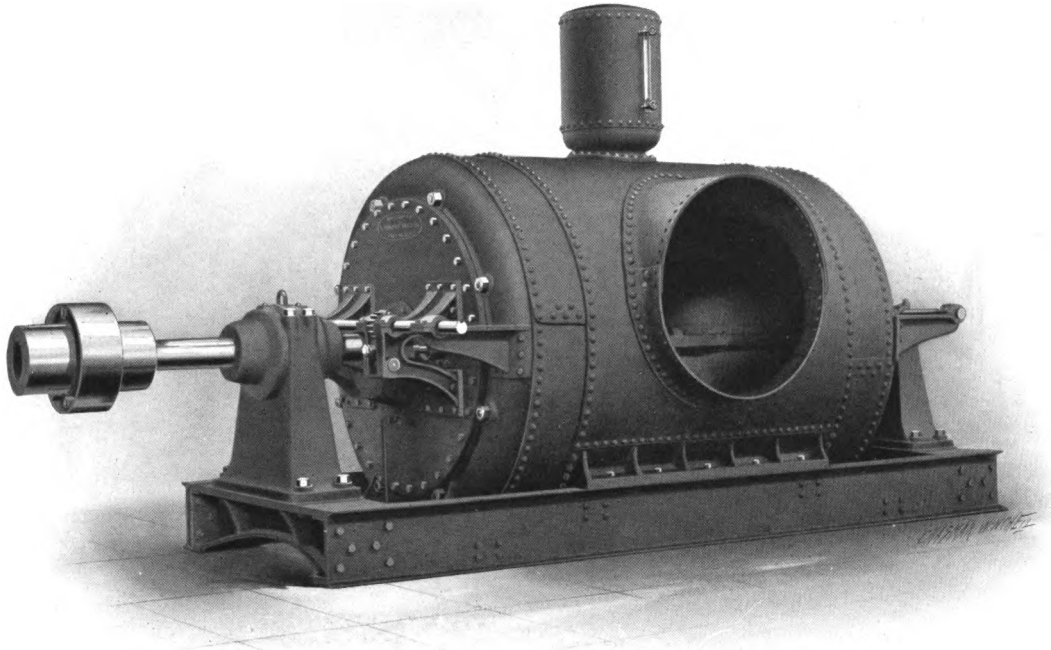
Digitized by Google



ENGRAVING No. 20.

Pair 48-inch turbines, driving generator in the power plant of the Sao Paulo Tramway, Light & Power Co., Sao Paulo, Brazil. Head, 75 feet; 2625 horse-power; 200 revolutions.

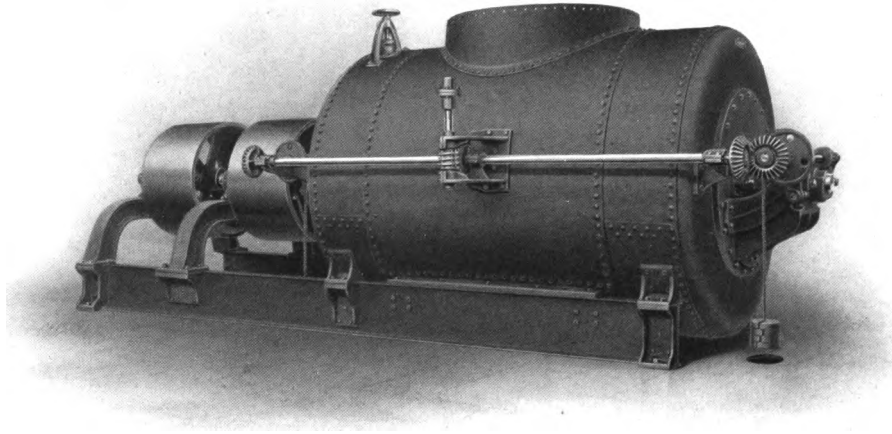
Digitized by Google



ENGRAVING No. 21.

Pair 39-inch turbines driving generator 400 revolutions; 1400 horse-power, 160 feet head. Three pairs, together with two exciter turbines, supply pipes, gate valves and head gate irons were furnished the Cascade Water, Power and Light Co , Cascade, British Columbia.

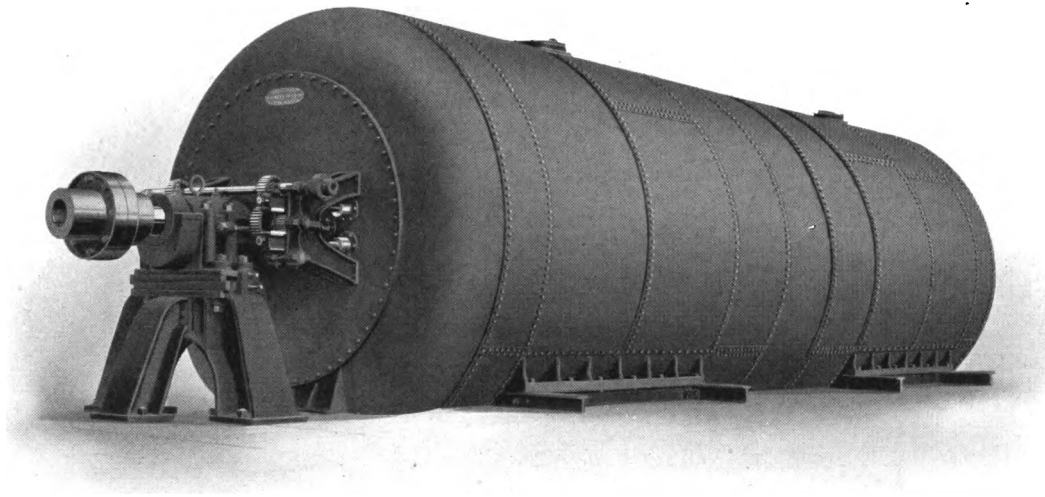
Digitized by Google



ENGRAVING No. 22.

Pair of horizontal shaft centre discharge Turbines operating generator under 85 feet head in the plant of the Rochester Gas & Electric Co., Rochester, N. Y.

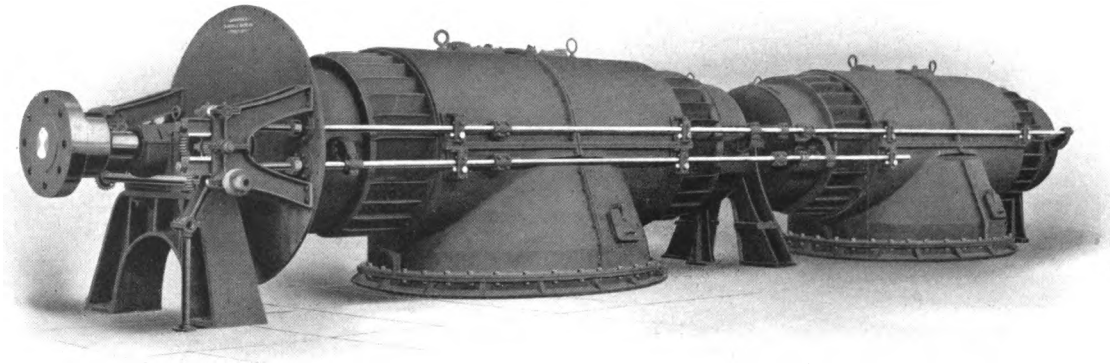
Digitized by Google



ENGRAVING No. 23.

Two pairs of center discharge Turbines mounted in a steel flume. Four lines developing 10000 horse power under 40 feet head were furnished the Winnipeg General Power Co., Winnipeg, Manitoba.

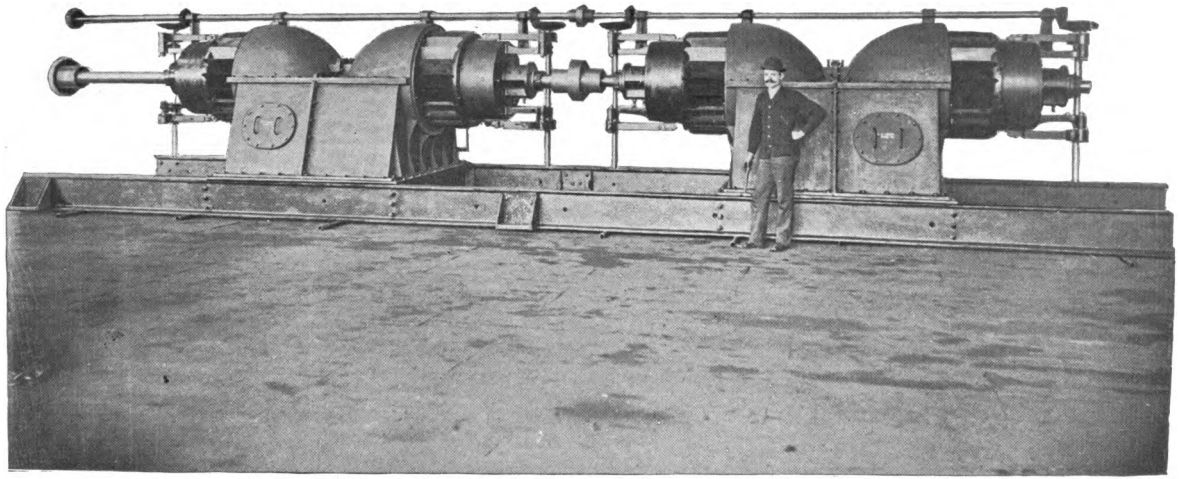
Digitized by Google



ENGRAVING No. 24.

Two pairs of 51-inch Turbines developing 3000 horse power under 31 feet head. Eight settings like this were furnished the Montreal Light, Heat & Power Co., Montreal, Canada, for their "Chambly Plant." We also furnished seven similar settings to the Hudson River Power Transmission Co., for their plant at Mechanicsville, N. Y. Head 17 feet.

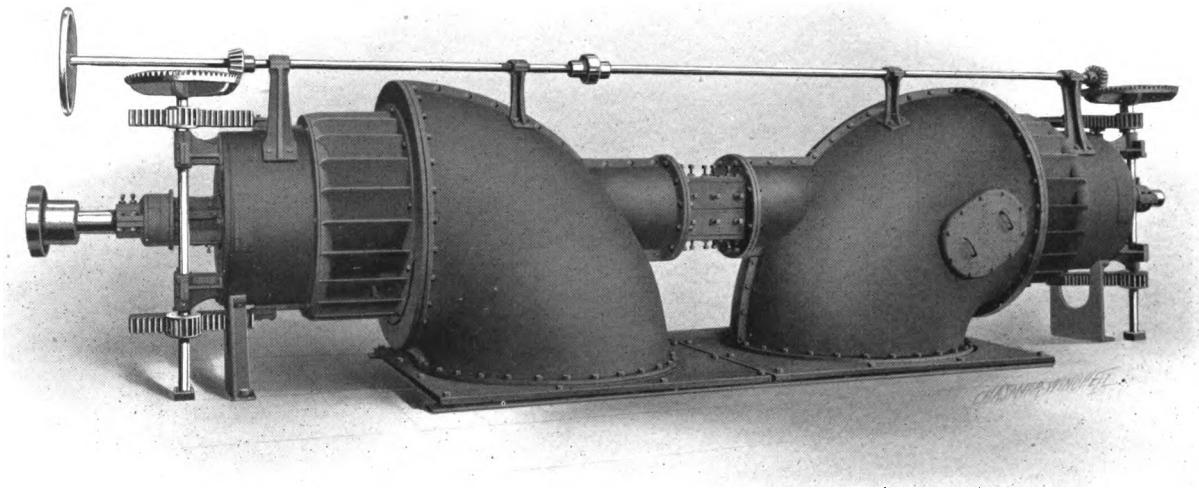
Digitized by Google



ENGRAVING No. 25.

Two pairs of 30-inch Turbines on horizontal shaft, mounted on cast iron draft chests arranged for either stone or wood flumes. This is a very good way to arrange wheels where head of water is low and high speed and great power is desired. It is not necessary to mount draft chests on steel beams. They can rest on a stone or wood floor. We have built many settings of this kind.

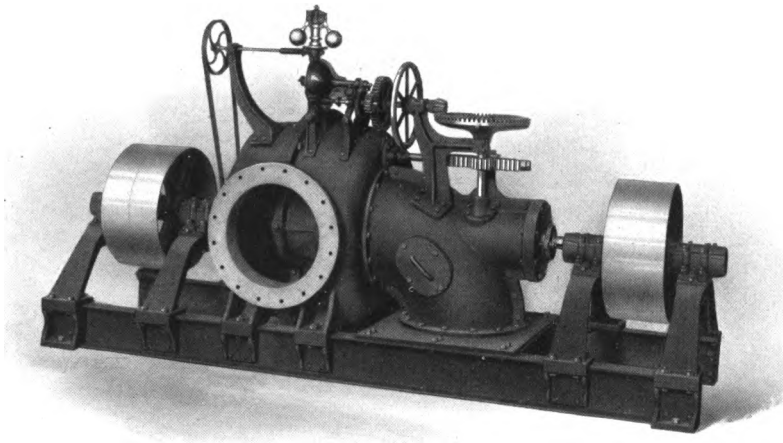
Digitized by Google



ENGRAVING No. 26.

Two horizontal shaft 36-inch Turbines mounted on cast iron quarter turns to set in stone or wood flumes, built for the Cecil Paper Co., Rising Sun, Md. Head 14 feet.

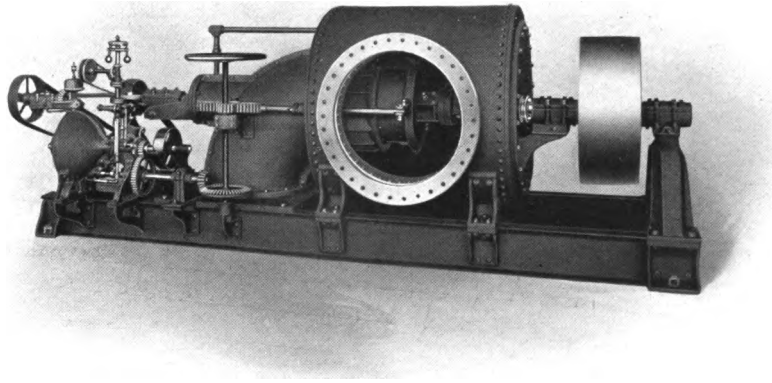
Digitized by Google



ENGRAVING No. 27.

Single horizontal shaft 12-inch Turbine in cast iron case mounted on beams driving two generators. Built for Thos. F. Nevins, Merrill, Fla. Head 20 feet. Water is supplied by artesian wells.

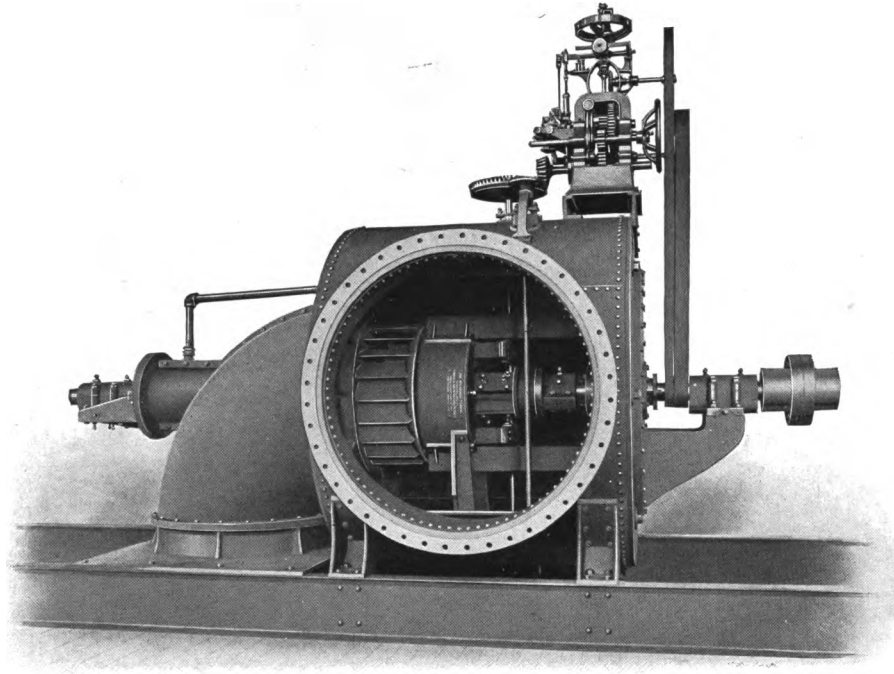
Digitized by Google



ENGRAVING No. 28.

Single 15-inch horizontal shaft Turbine in steel flume driving generator in the plant of the Hida Water Power Co., Japan. Head 50 feet.

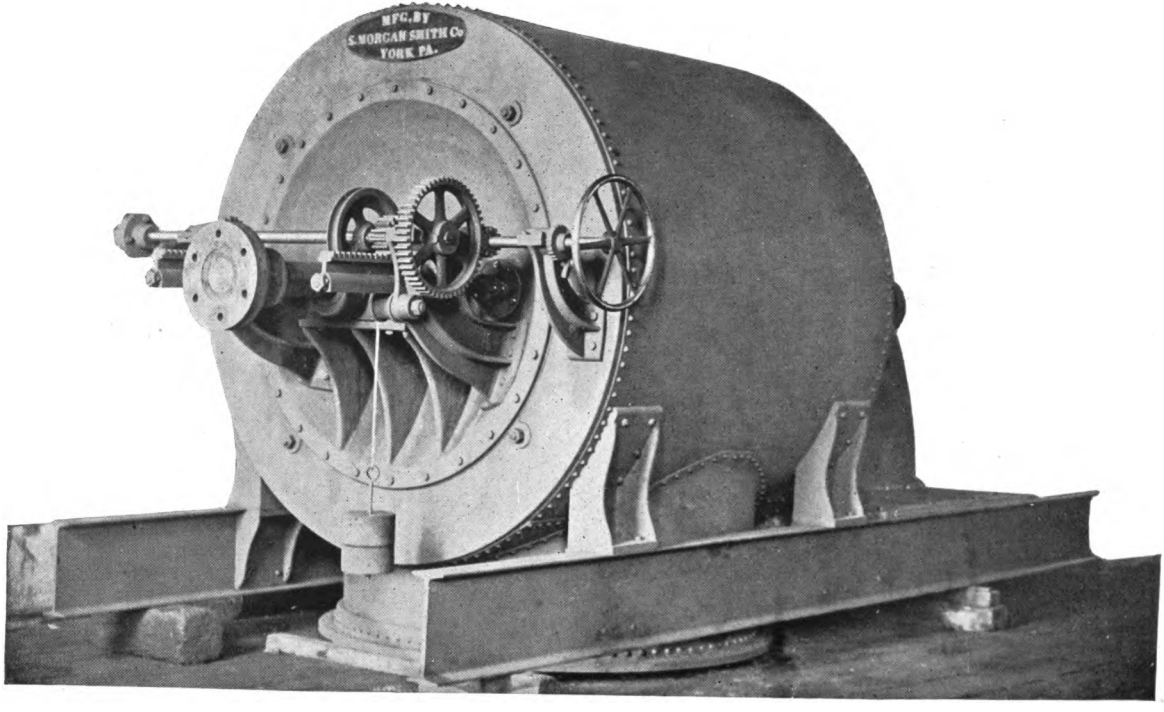
Digitized by Google



ENGRAVING No. 29.

Single 27-inch Turbine operating electric plant in Peru under 60 feet head, 400 revolutions, 600 horse power; direct connected to generator.

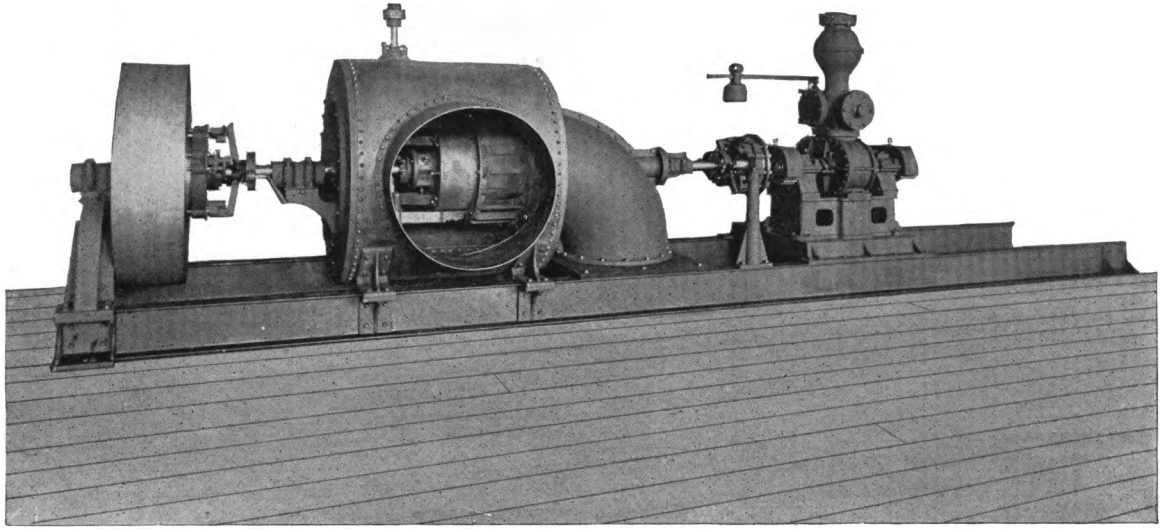
Digitized by Google



ENGRAVING No. 30.

Single 30-inch Turbine arranged to operate a direct connected generator. Three of these and one 12-inch developing 2300 horse power were furnished the Sanford Mills Co., Sanford, Me. Head, 60 feet. Power is transmitted eight miles. All gate gearing is on outside of wheel case.

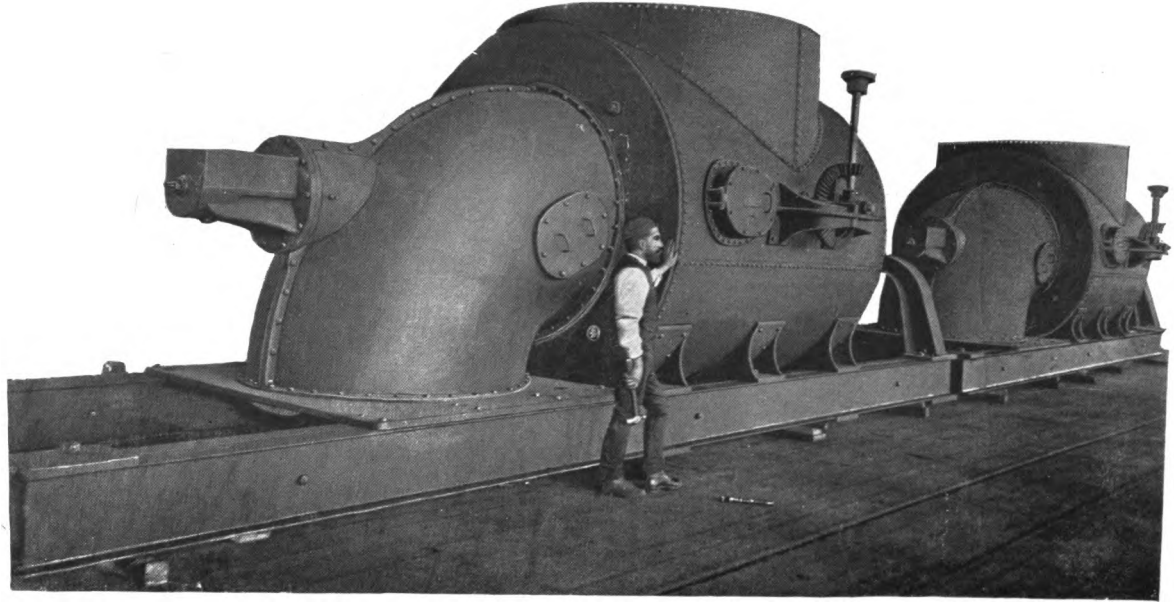
Digitized by Google



ENGRAVING No. 31.

Single 21-inch Turbine on horizontal shaft connected to a fire pump and a pulley driving dynamo by Worrall Friction Clutches. Wheel is connected to the side of a penstock containing a pair of horizontal shaft 30 inch Turbines of 300 horse power capacity which are driving Cotton Mill for Roberdel Manufacturing Co., Rockingham, N. C.

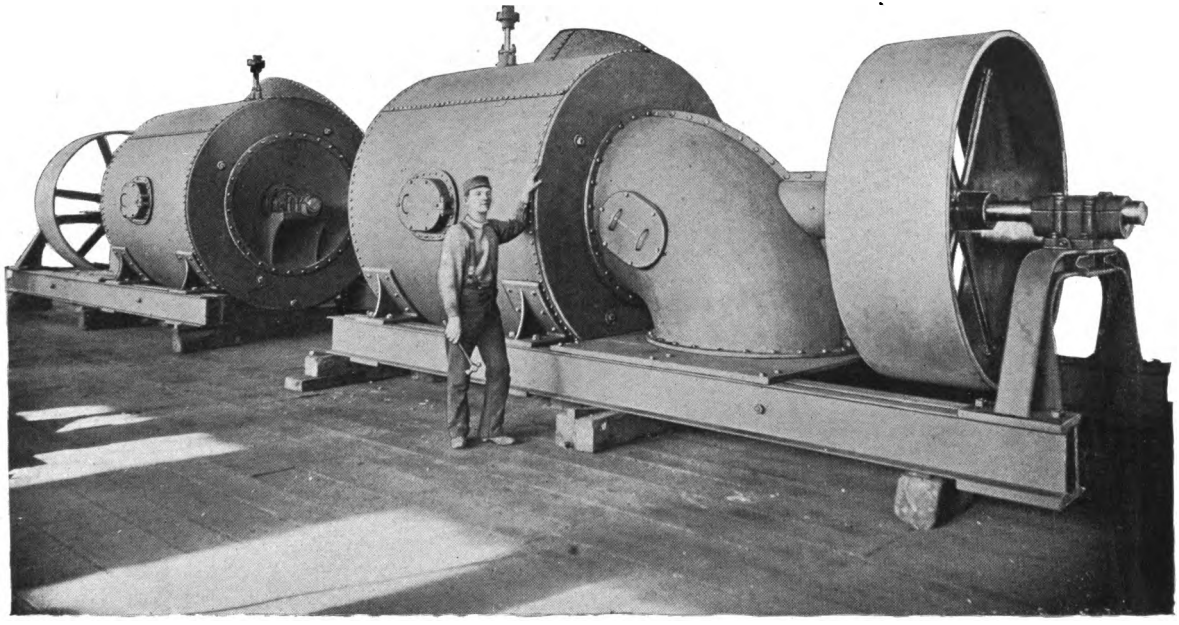
Digitized by Google



ENGRAVING No. 32.

Two single 39-inch Turbines on horizontal shafts developing 1436 horse power which is transmitted by rope sheaves. This outfit and a pair of 33-inch horizontal shaft Turbines were furnished the Minneapolis General Electric Co., Minneapolis, Minn.

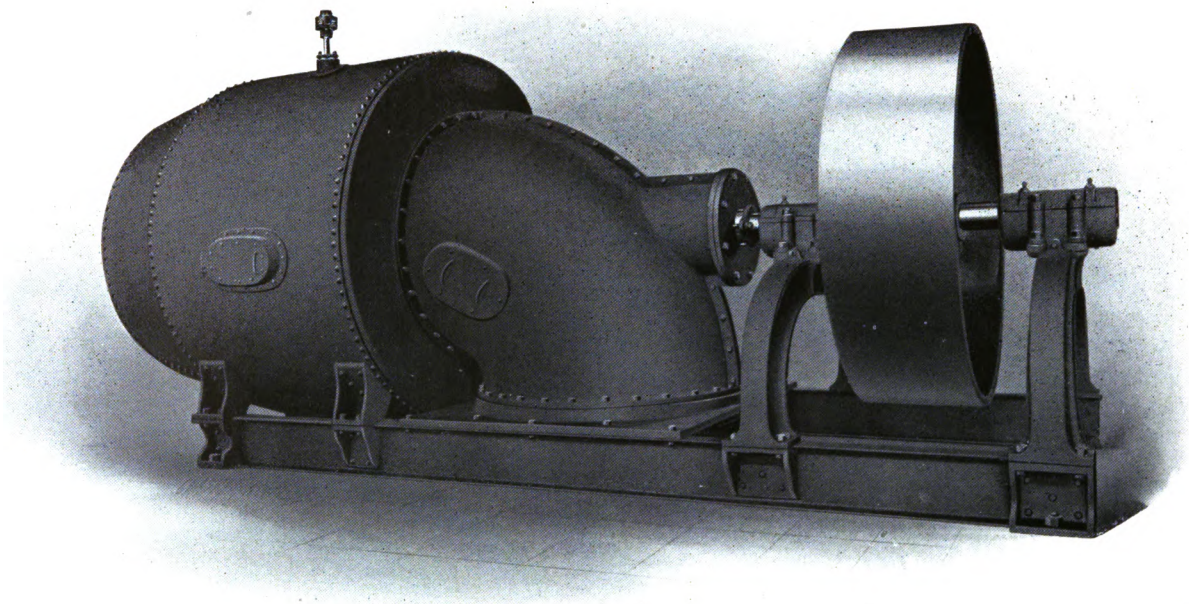
Digitized by Google



ENGRAVING No. 33.

Two single 33-inch Turbines, which with a 21-inch (not shown here) develop 417 horse power under 21 feet head. This outfit was furnished the Mauch Chunk Heat, Power and Electric Light Co., Mauch Chunk, Pa.

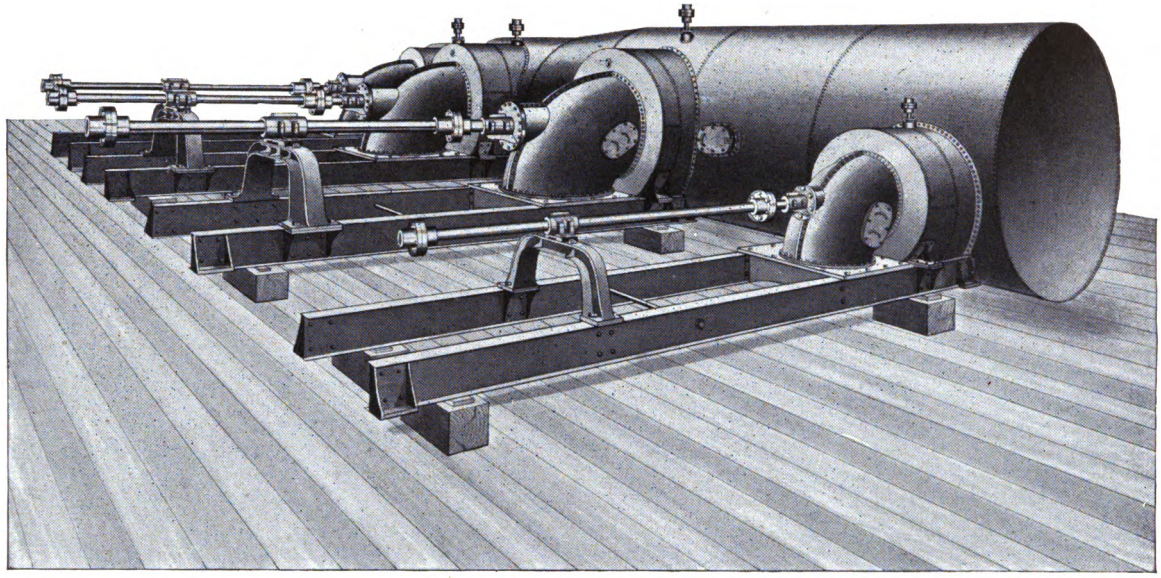
Digitized by Google



ENGRAVING No. 34.

Single 36-inch horizontal shaft Turbine arranged to drive a generator by belt. The water enters through one end of the steel flume in which the turbine is mounted.

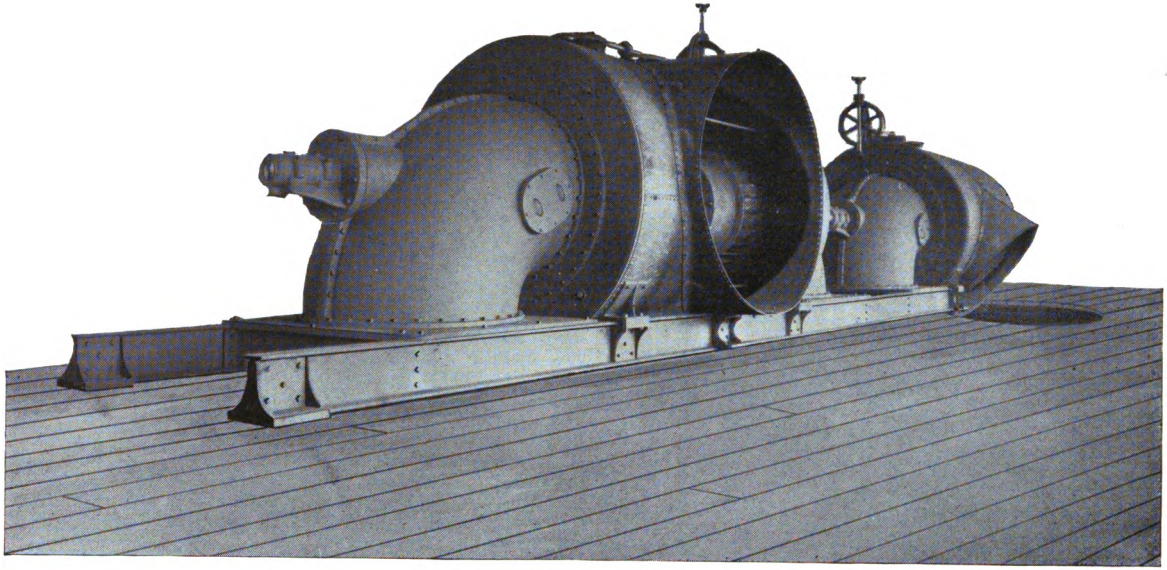
Digitized by Google



ENGRAVING No. 35.

Two 39-inch, one 33-inch and one 21-inch Turbines on horizontal shafts, supplied from one feeder pipe 650 feet long, 11 feet diameter a ltarge end, reduced in size where Turbines are connected. The two 39-inch Turbines are direct connected to four pulp grinders. This outfit was furnished the Newton Falls Paper Co., Newton Falls, N. Y. Head 42 feet. 2220 horse power.

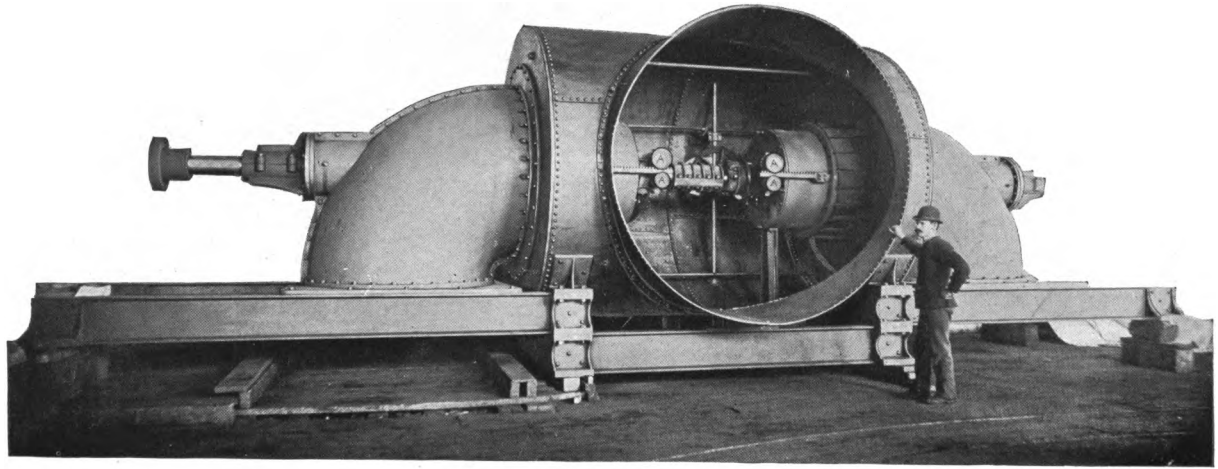
Digitized by Google



ENGRAVING No. 36.

Two pairs 42-inch Turbines operating a direct connected generator under 30 feet head in the No. 3 cotton mill of the Clifton Manufacturing Co., Clifton, S. C. In connection with this outfit we furnished a 27-inch horizontal Turbine of 225 horse power for driving dynamo and fire pump. We have also furnished this company Turbines for their Nos. 1 and 2 mills aggregating 3500 horse power.

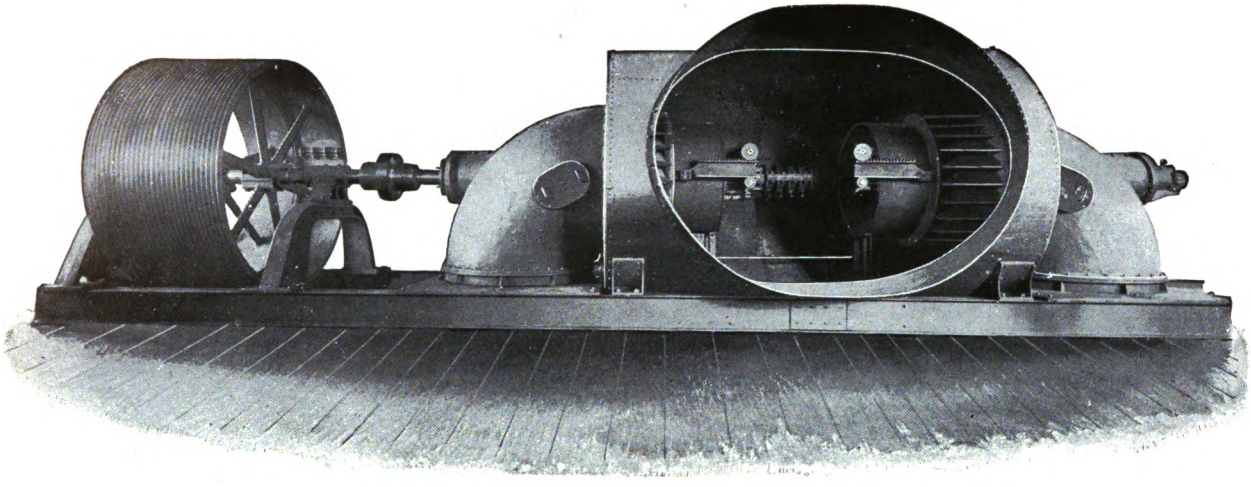
Digitized by Google



ENGRAVING No. 37.

Pair of 39-inch Turbines developing 1000 horse power under 33 feet head, built for the International Paper Co., Piercefield, N. Y. Also furnished four pairs of 33-inch, one single 39-inch, one single 27-inch and one single 18-inch wheels aggregating 4350 horse power.

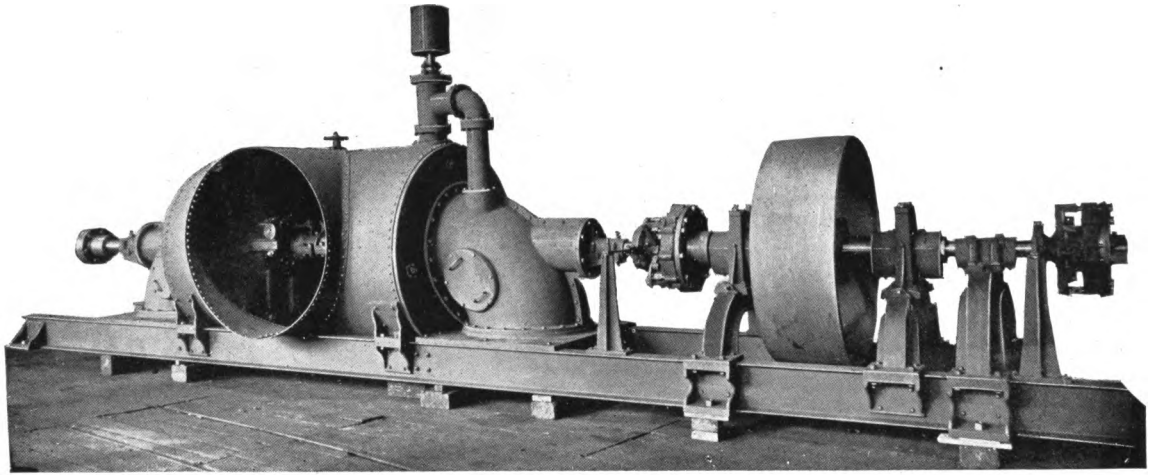
Digitized by Google



ENGRAVING No. 38.

Pair of 51-inch Turbines, 1300 horse power, with 10 feet diameter rope sheave, carrying 27 ropes 1½-inch diameter, driving generator in the No. 2 station of the Sacramento Electric, Gas and Railway Co., Folsom, Cal. We also furnished this company 4 pairs of 30-inch horizontal Turbines for their No. 1 station, aggregating 6500 horse power.

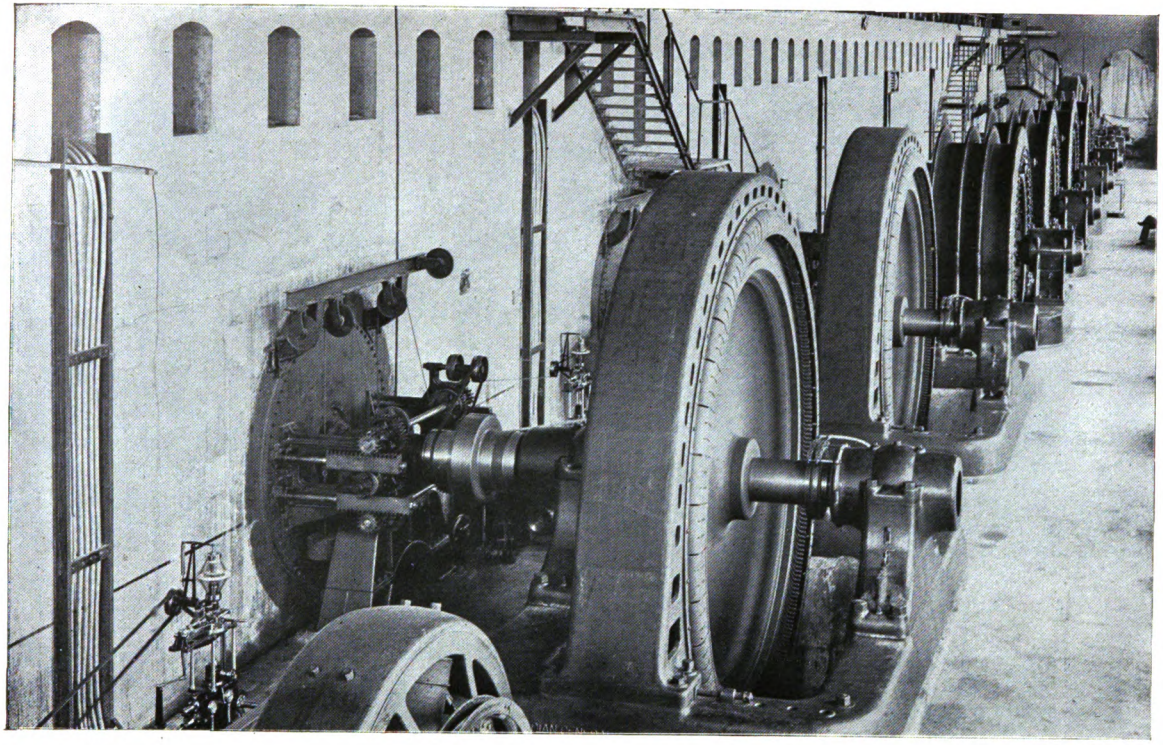
Digitized by Google



ENGRAVING No. 39.

Pair of 18-inch Turbines arranged to operate under 66 feet head the Electric plant of Eugene L. Ashley, Fort Ann, N. Y. Generator is connected direct to wheel shaft An arc dynamo is operated from pulley attached to a quill to which is fitted a Worrall friction clutch. On extreme end of shaft is a friction clutch for connection to fire pump. The device admits of running fire pump and arc dynamo independent.

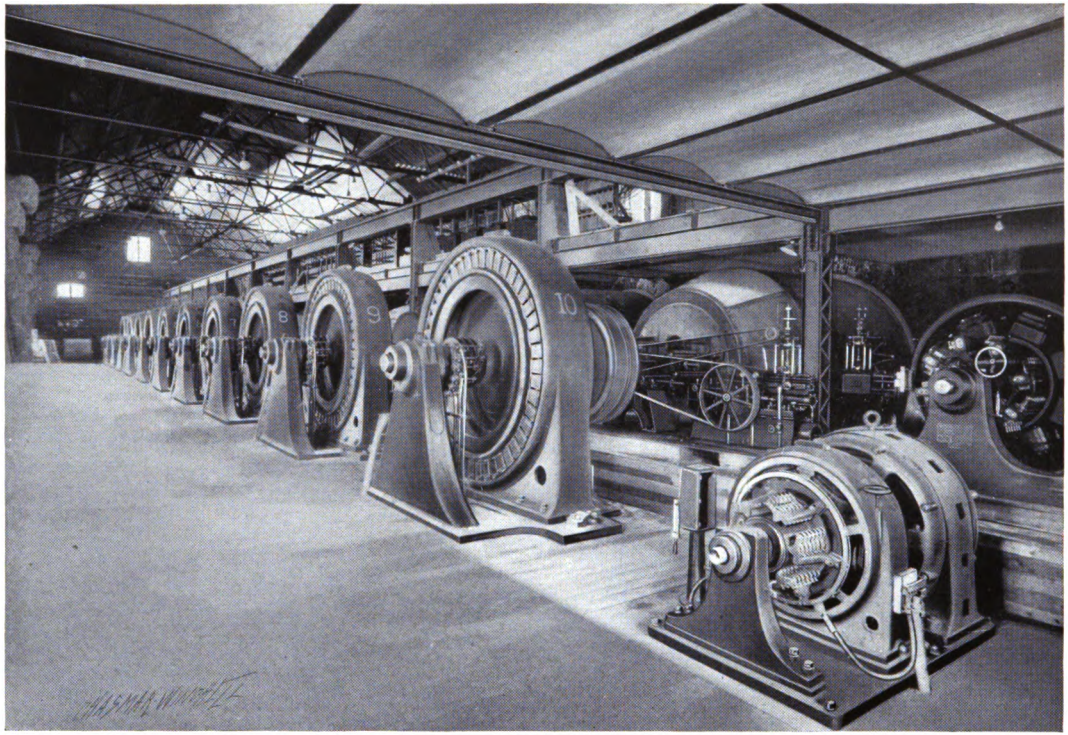
Digitized by Google



ENGRAVING No. 40.

Interior "Chambly Plant" of the Montreal Light, Heat & Power Co., Montreal, Canada, where thirty-six Turbines are developing 25000 horse power under 31 feet head.

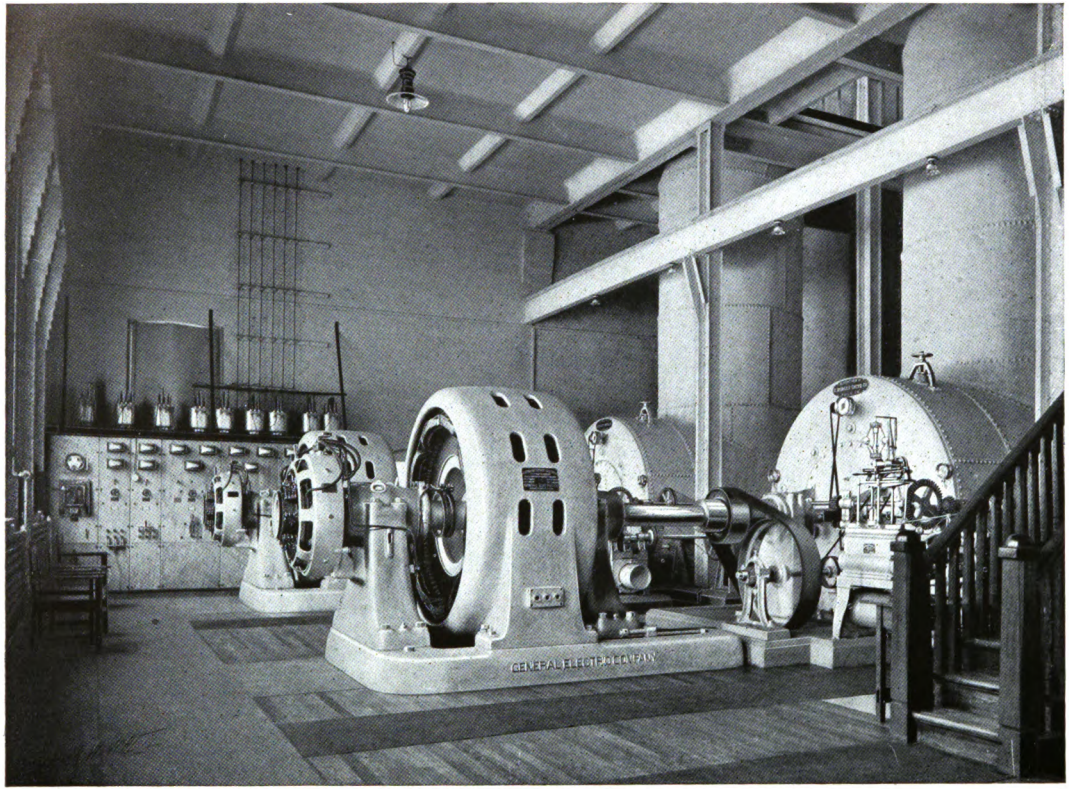
Digitized by Google



ENGRAVING No. 41.

Interior of the Missouri River Power Co's., plant where six pairs of Turbines are driving generators and one pair driving an exciter.

Digitized by Google



ENGRAVING No. 42.

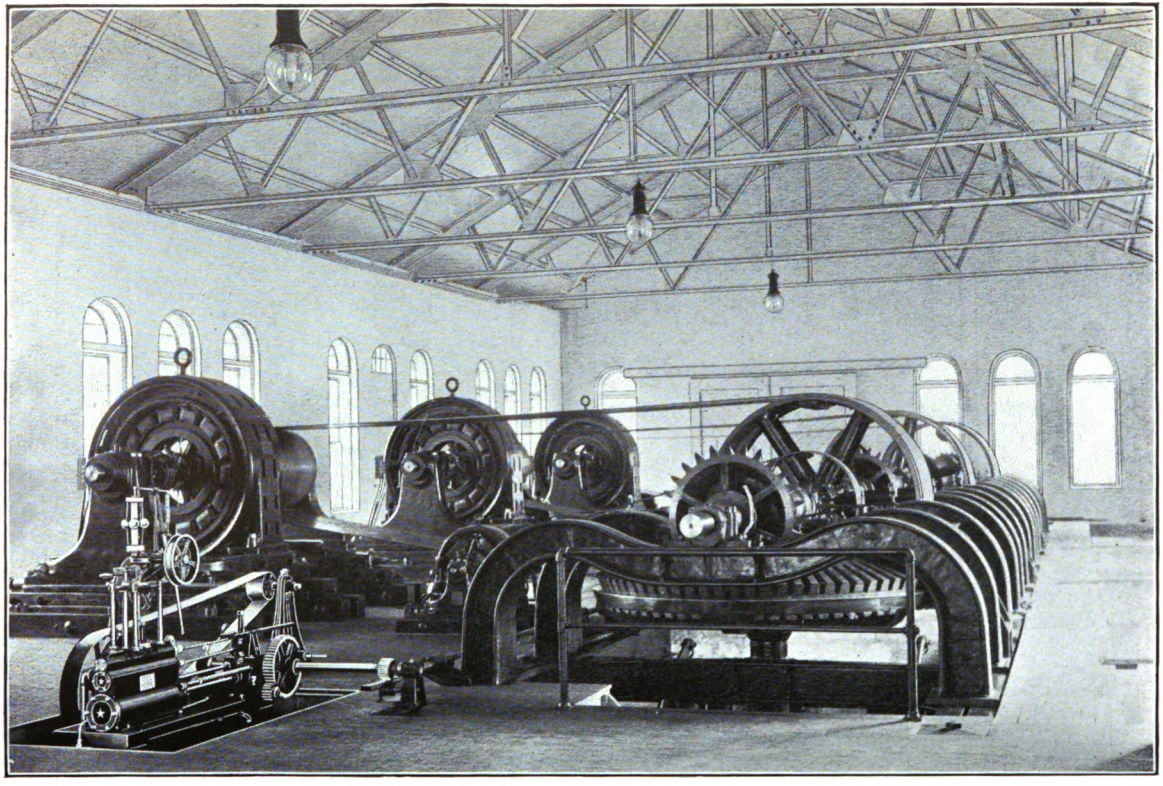
Interior of the Union Bag & Paper Co.'s plant, Sandy Hill, N. Y., in which are three pairs of Turbines, each pair developing 1200 horse power under 55 feet head.

Digitized by Google

ENGRAVING No. 43.

Bulkhead and inlet pipes conveying water to four pairs 30-inch Turbines at the power station of the Sacramento Electric Gas & Railway Co., Folsom, Cal. Head 55 feet. Turbines direct connected to generator.

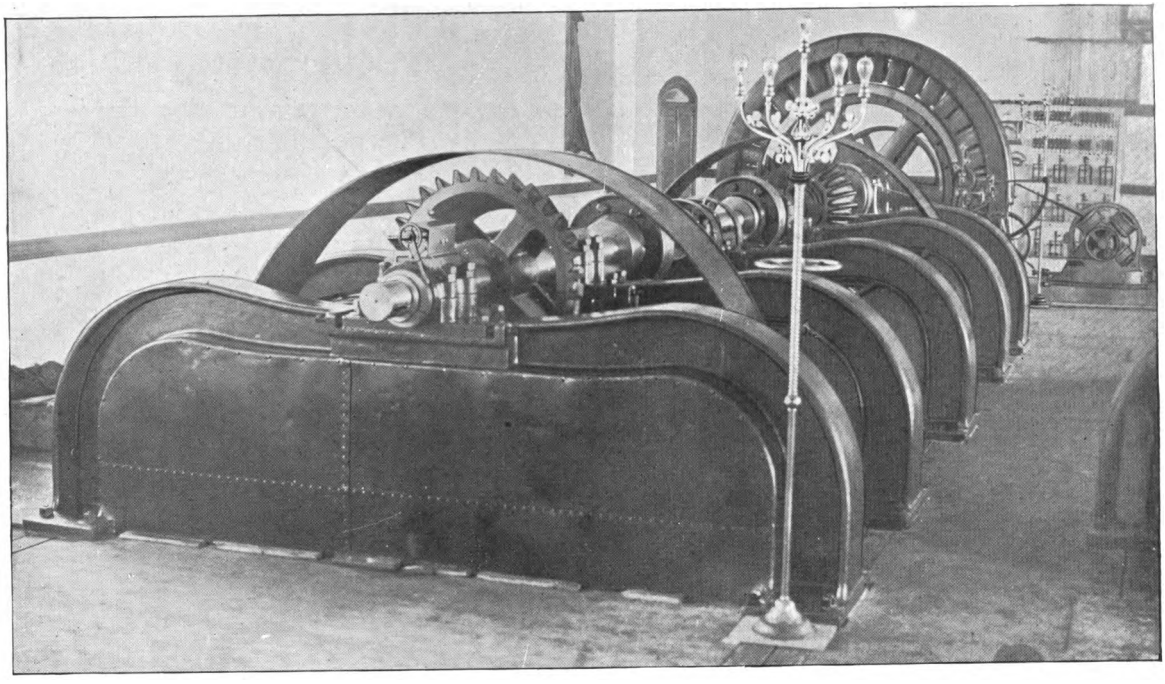
Digitized by Google



ENGRAVING No. 44.

Generators operated by four vertical shaft Turbines 72-inch diameter, developing 3600 horse power under 19 feet head. The gates of all the turbines are operated by one Type "B" Lombard Governor working in connection with a lever gate hoisting device, thereby dispensing with gears used in ordinary practice. The entire outfit of turbines and machinery was built for the Trade Dollar Mining Co., Silver City, Idaho.

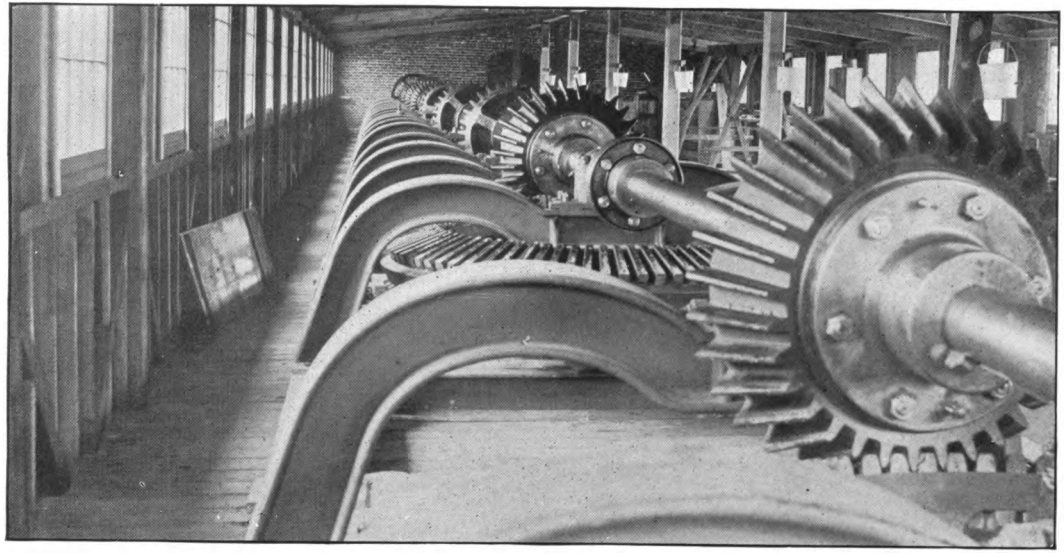
Digitized by Google



ENGRAVING No. 45.

One 400 Kilo Watt generator direct connected to jack shaft driven by two vertical shaft 60-inch Turbines. Eight outfits like this of 2500 horse power each, three outfits of 66-inch wheels and one outfit of 45-inch wheels including bevel mortise wheels 10 feet in diameter, 18-inch face, shafting, etc., were furnished the Montreal Cotton Company, Valley Field, Quebec, Canada. This plant is most substantially constructed and enjoys the distinction of being the first to use direct connected gear-driven generators.

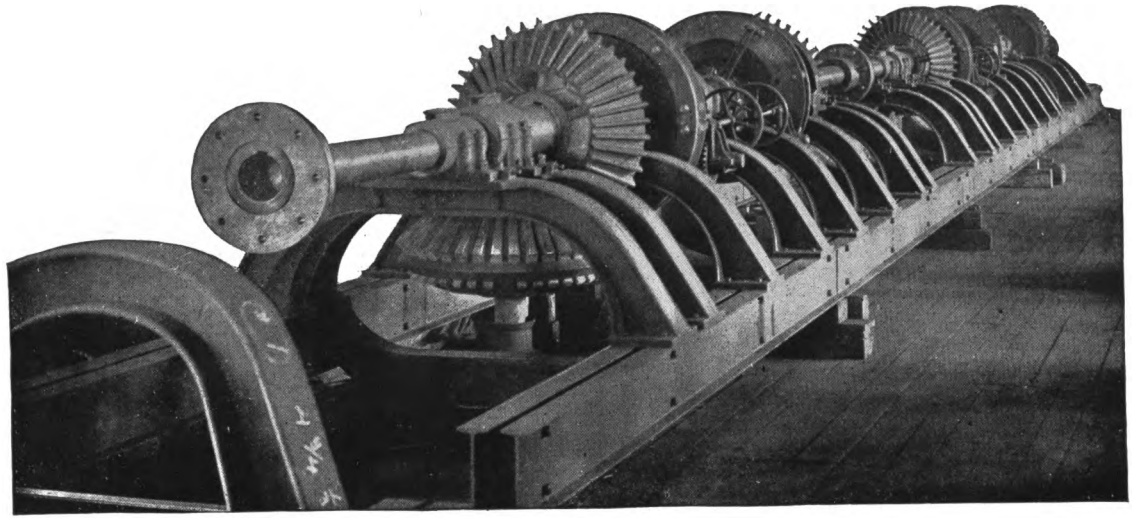
Digitized by Google



ENGRAVING No. 46.

Jack shaft, gears and harness used in connection with eight vertical shaft Turbines developing 1385 horse power under 10 feet head. Shaft is about 140 feet long and is connected to the generator. The plant is located on the Yadkin River and is owned by the Fries Manufacturing Company, Salem-Winston, N. C., to which towns the power is transmitted, a distance of 13 miles. We have furnished this company two outfits like above engraving.

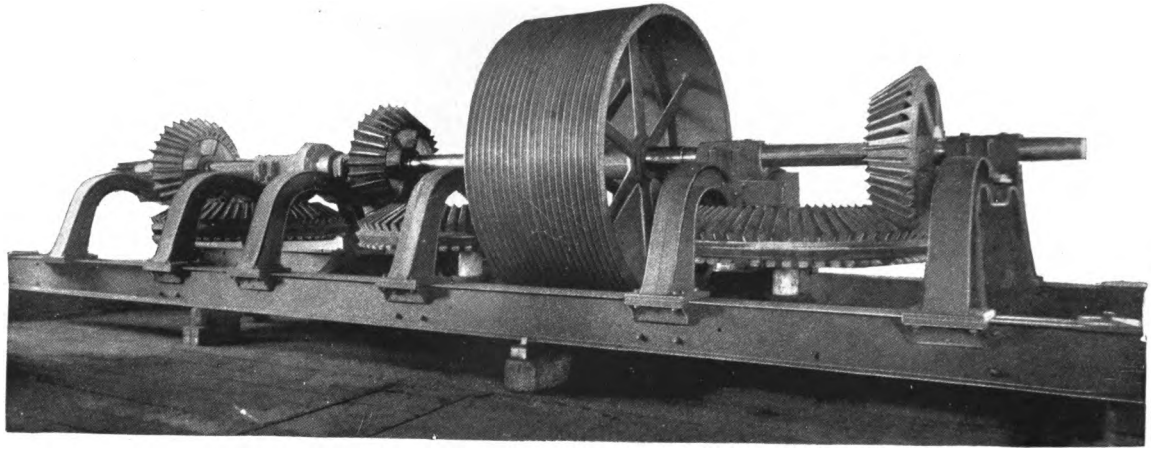
Digitized by Google



ENGRAVING No. 47.

Machinery used in connection with five vertical shaft 60-inch Turbines operating under 10 feet head in the pumping plant of the City of Bangor, Maine. Each of the five bevel pinions is attached to a cast steel quill, to which is fitted a 48-inch Worrall friction clutch. By this device the power of any of the Turbines can be thrown on or off without stopping.

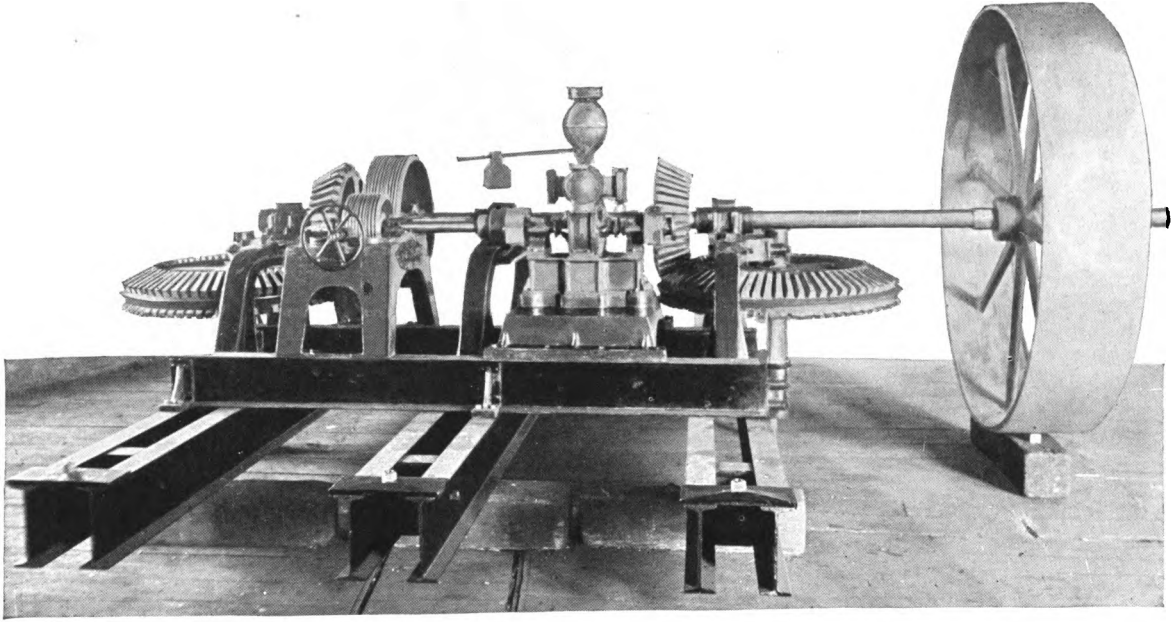
Digitized by Google



ENGRAVING No. 48.

Machinery used in connection with three vertical shaft 54-inch Turbines, operating under 10 feet head at the Cotton Mills of the Muscogee Manufacturing Company, Columbus, Ga. The rope sheave is 8½ feet diameter and carries twenty ropes 1¼ inches diameter.

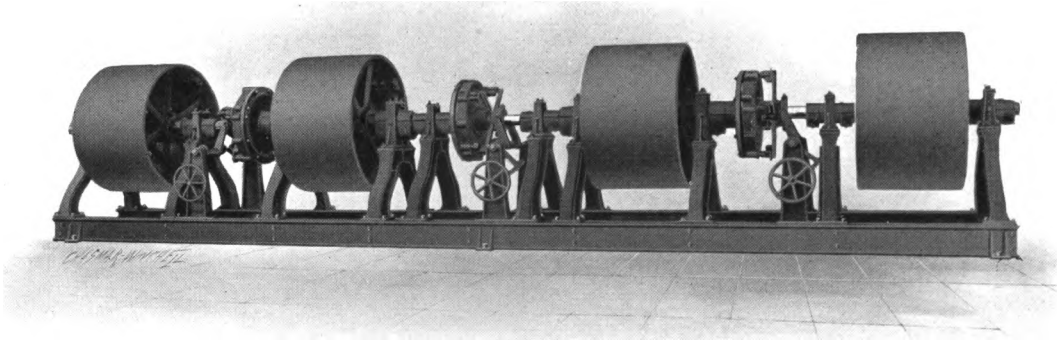
Digitized by Google



ENGRAVING No. 49.

Outfit of machinery, including a fire pump which, together with two vertical shaft 51-inch Turbines, was furnished the Monbo Manufacturing Company, Monbo, N. C. A similar outfit was also furnished the Long Island Cotton Company, Statesville, N. C.

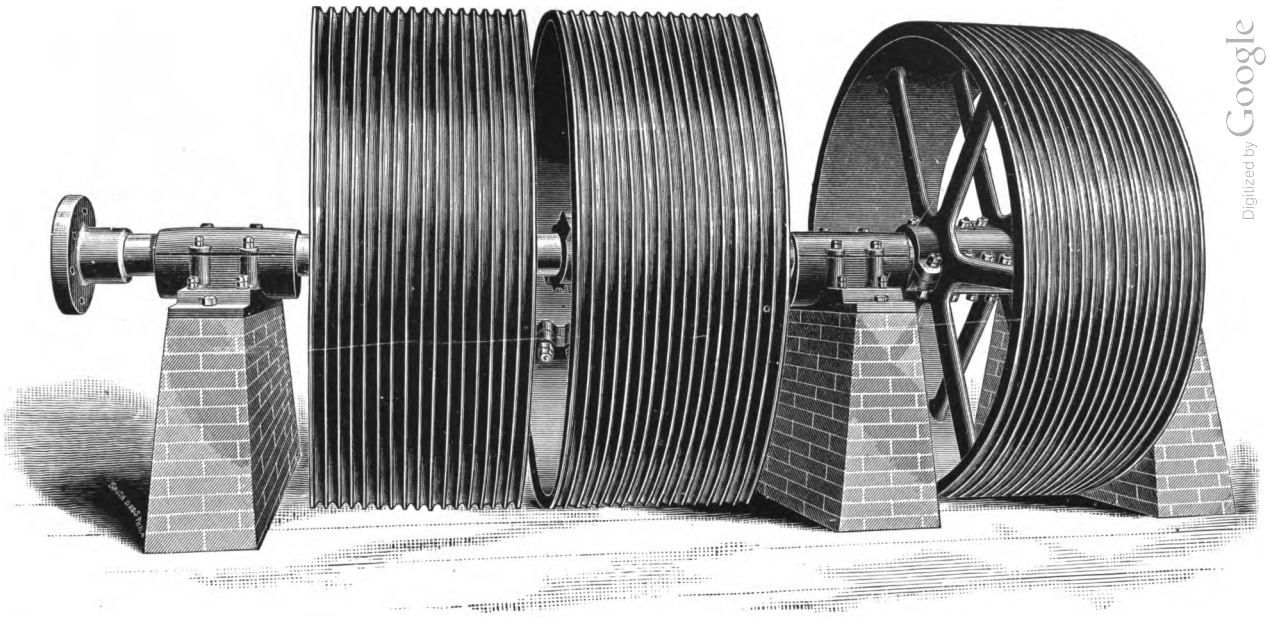
Digitized by Google



ENGRAVING No. 50.

Section of line shaft with pulleys, friction clutches, shipper devices and yokes supporting same mounted on steel beams, built for Hon. Samuel P. White, Beaver Falls, Pa. The total length of the line shaft was 170 feet.

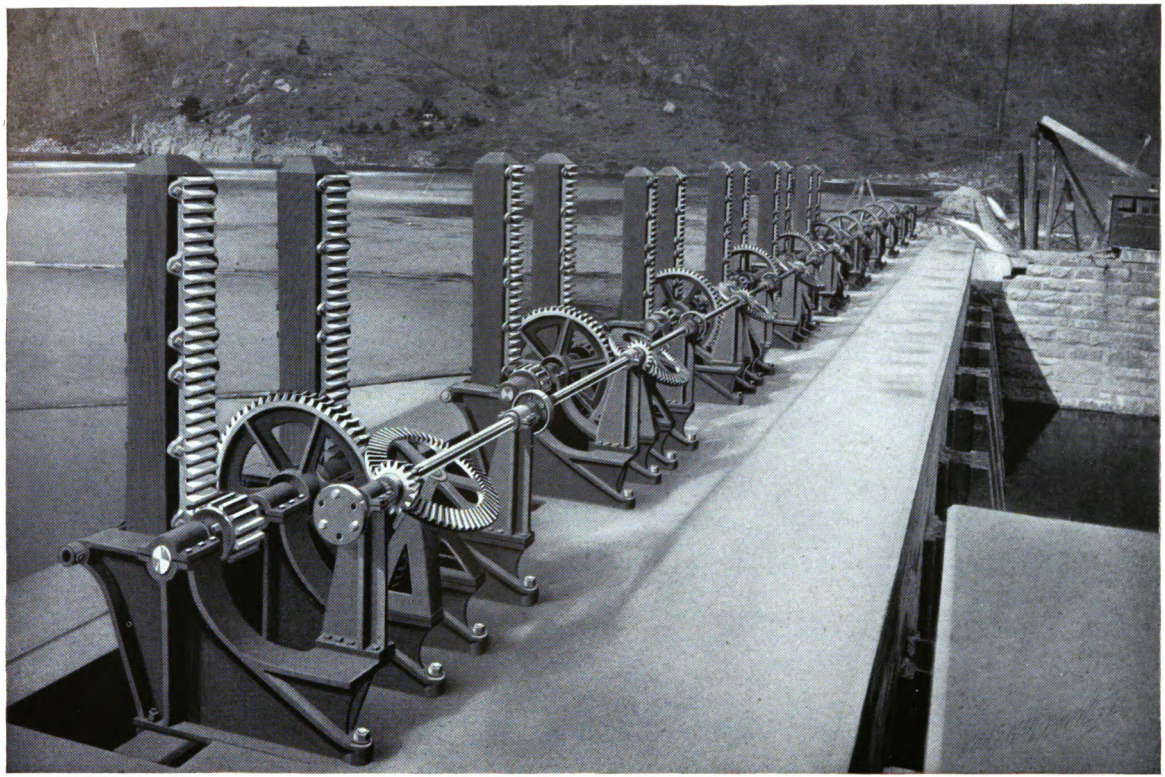
Digitized by Google



ENGRAVING No. 51.

Rope Drive furnished the Clifton Manufacturing Company, Clifton, S. C. *We are prepared to furnish Rope Wheels twenty feet diameter and smaller to carry any number of ropes.*

Digitized by Google

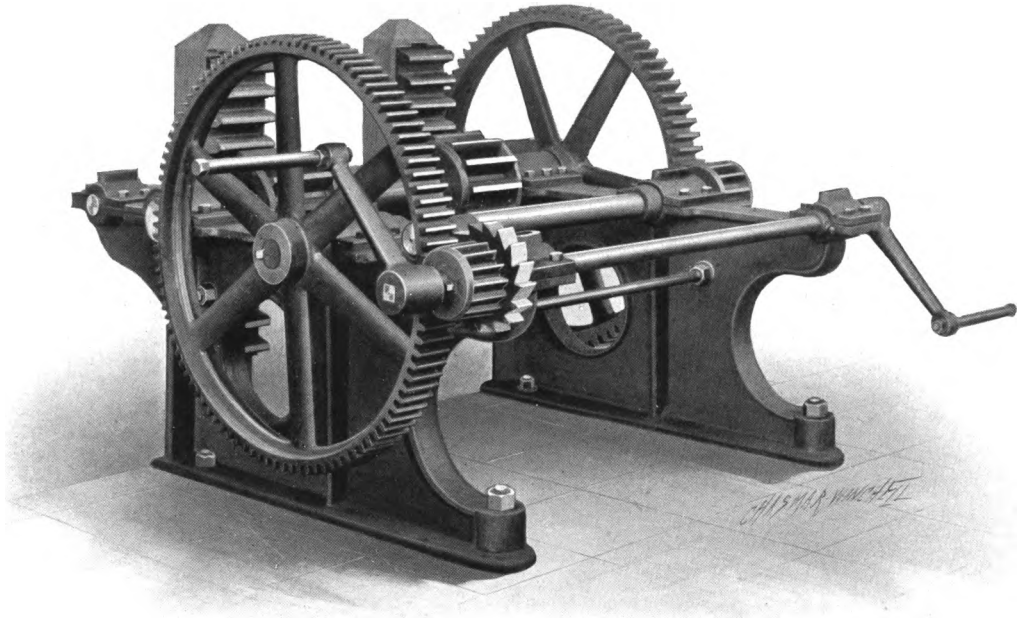


ENGRAVING No. 52.

Ten large Head Gate Hoists operated by one shaft driven by motor. Hudson River Water Power Co., Spiers Falls, N. Y.

Digitized by Google

GEARED HOIST FOR OPERATING BULK-HEAD GATES. STYLE "K."



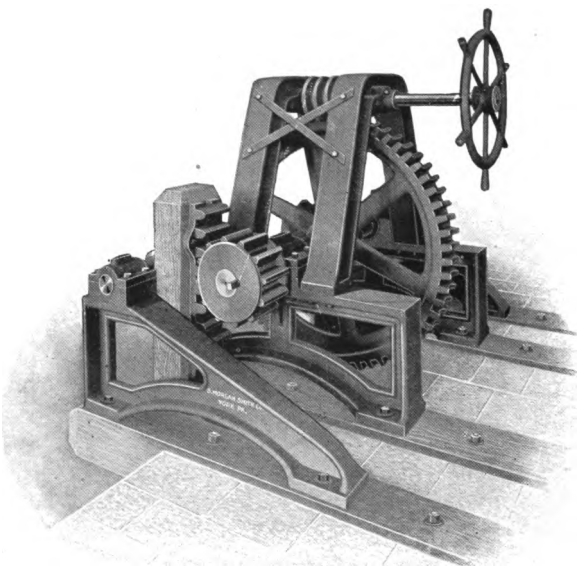
ENGRAVING No. 53.

Our list of patterns of head-gate irons being unusually complete, we are prepared to accommodate customers with whatever they require. State size of gate to be raised and depth of water in front of it.

Digitized by Google

WORM GEARING FOR OPERATING BULK-HEAD GATES.

STYLE "G."



ENGRAVING No. 54.

The above shows an arrangement for operating the head gates in canals, mill races and other water ways. Often great difficulties are experienced in raising or lowering these gates without such an arrangement as shown above. This device makes it possible to lower or raise the heaviest and hardest working gates with ease.

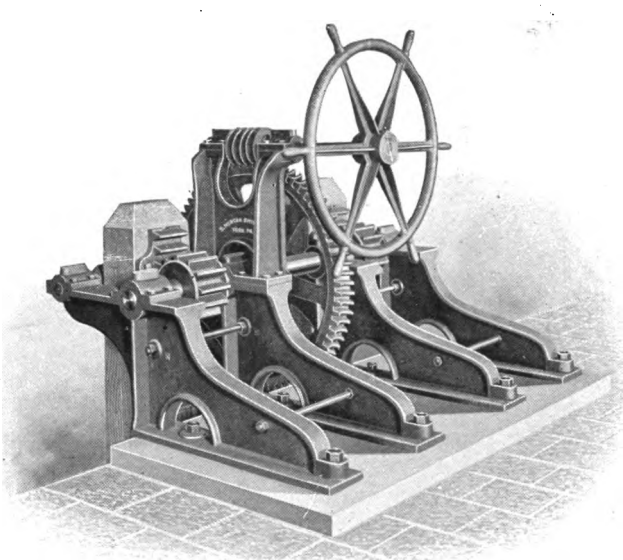
It is one which is much needed, and those using water powers will find the purchase and use of it a great convenience as well as a saving of time and money.

When ordering, give the size of gate or gates, as the case may be, the height they are to be raised and depth of water in front of gate.

Digitized by Google

WORM GEARING FOR OPERATING BULK-HEAD GATES.

STYLE "EE."

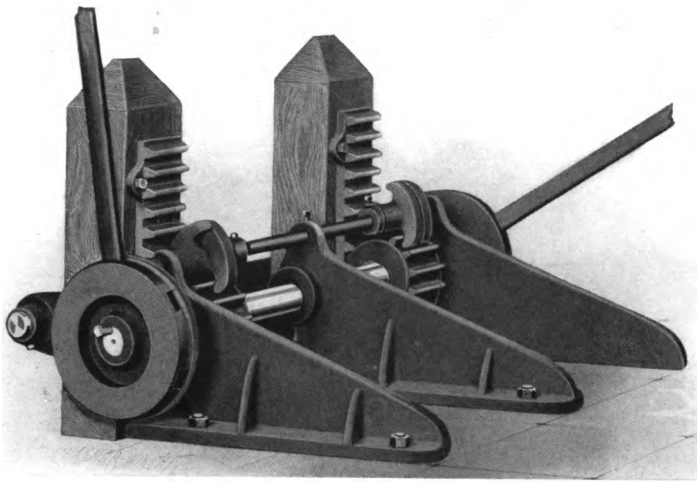


ENGRAVING No. 55.

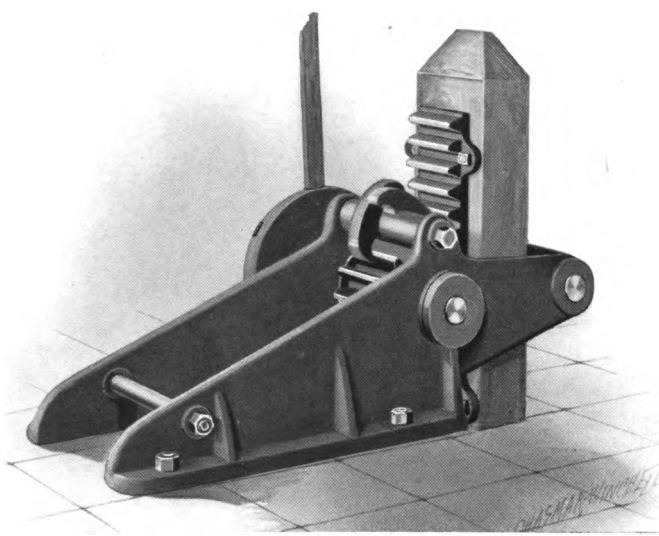
The above shows a powerful double stem worm gear hoist for raising large gates in front of supply pipes to turbines. As will be seen there are two gate stems attached to the gate, to which are bolted rack segments, engaged by pinions keyed to the shaft operated by the worm wheel.

Digitized by Google

GATE HOISTING DEVICES.



ENGRAVING No. 56 STYLE "HH."

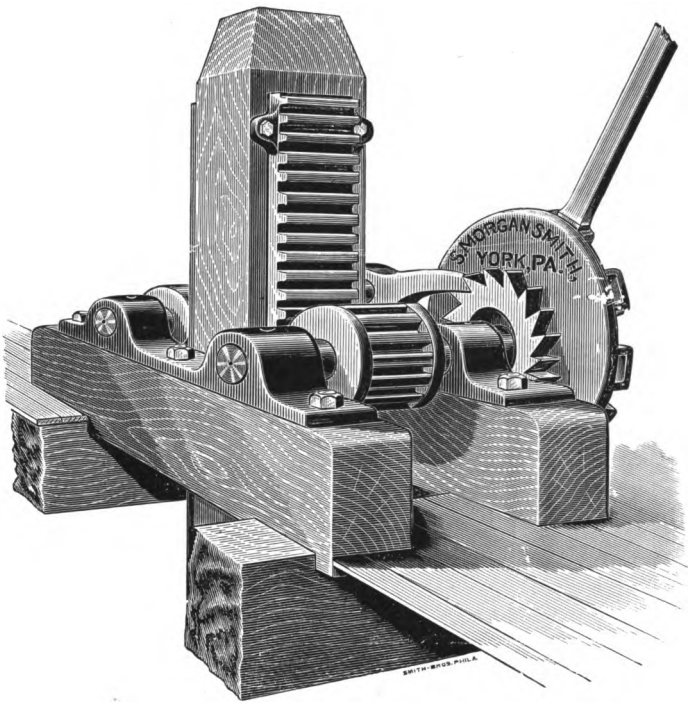


ENGRAVING No. 57. STYLE "H."

Digitized by Google

GATE HOISTING DEVICE.

STYLE "A."

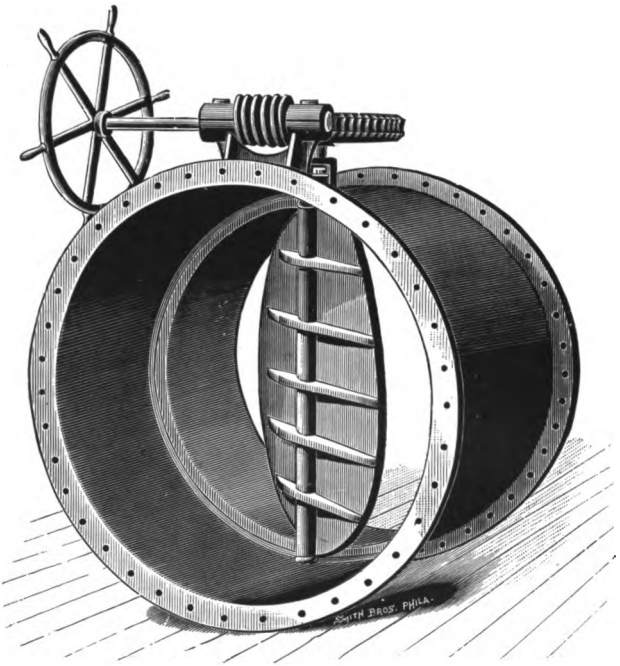


ENGRAVING No. 58.

The above represents a cheap, but strong and effective gate hoisting device. All head gates should be provided with suitable devices for raising and lowering the gates. The worm rigging shown on page 93 is one of the strongest and best arrangements that can be used. For ordinary gates the device as shown above will answer every purpose. As will be observed from the engraving, there is a heavy spur pinion working into the rack segment which is bolted to the gate stem. The pinion and roll shafts are held firmly in position by means of journals cast in connection with a heavy plate securely bolted to a wooden frame. When ordering, give size of gate, the height it is to be raised and the depth of water in front of it.

Digitized by Google

WICKET GATES FOR SUPPLY PIPES TO WATER WHEELS.



ENGRAVING No. 59.

The above style of gate will be found very convenient for many places. We are prepared to funish Gates of any size to meet the requirements of the location.

Digitized by Google

WORRALL FRICTION COUPLING.

SIMPLE, DURABLE AND RELIABLE.

ENGRAVING No. 60.

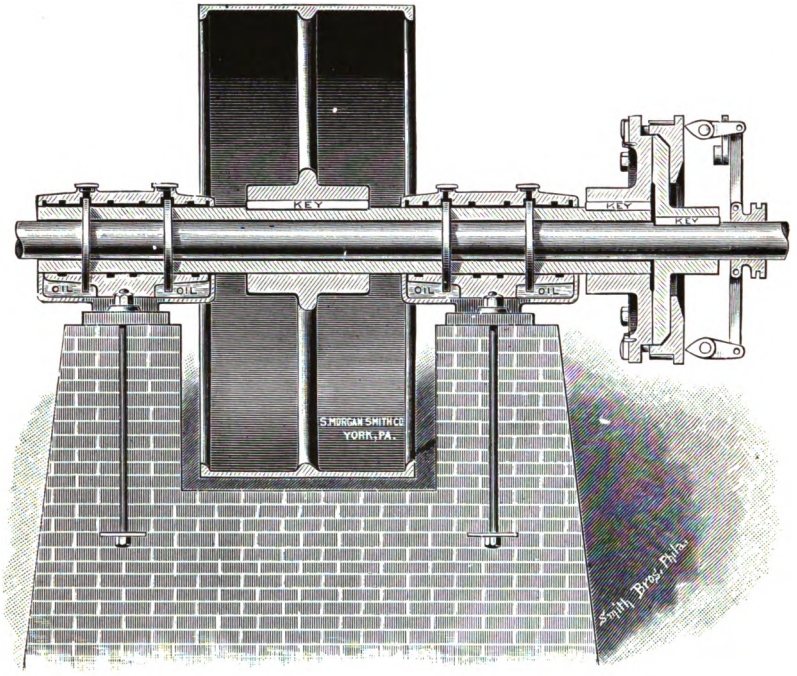
The Worrall Friction Clutch is made in sizes to transmit from 1 to 2500 horse power. It automatically centers and adjusts itself. Will work exposed to frost, steam, acids and water.

Each part of the Friction is keyed solid to shaft upon which it runs. The power is not transmitted through bolts, loose joints nor working parts, but directly through parts keyed to the shafts, making practically a solid coupling.

The Clutch is positive and will gradually start or stop any connected shafting and machinery without sudden strain upon belts or gears. See price list, page 99.

Digitized by Google

FRICTION CLUTCH AND QUILL PULLEY.



ENGRAVING No. 61.

This engraving shows a Worrall Friction Clutch connecting line shaft with a Quill or Hollow shaft carrying pulley. It will be seen that the Quill is supported by independent bearings and is not dependent on the journals supporting the shaft which passes through the Quill. Where practical we advise this arrangement of Clutch and Pulley and especially when pulleys are large and heavy belts are to be used.

Prices quoted on application.

Digitized by Google

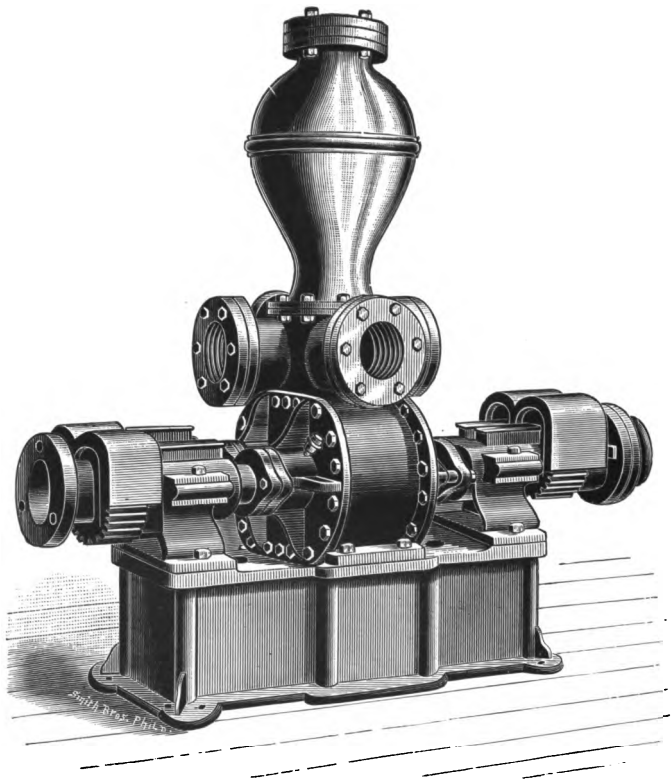
PRICE OF WORRALL FRICTION CLUTCHES.

Size of Clutch.	Horse Power at 100 Rev.	Space on Shaft for Coupling and Shipper. Inches.	Price.	Price of Shipper Forks.
6	2	7	$ 30	$ 2.50
8	2½	8	40	2.75
9	3	10	50	3 50
10	5	12	65	4 00
12	8	18	100	4.50
13½	12	18	125	5.00
15	18	20	150	5 50
18	30	22	175	6.00
21	50	24	200	6.50
24	75	24	300	7.50
27	125	26	350	8 00
30	150	28	400	9 00
33	200	30	450	10.00
36	250	32	500	11.00
42	385	34	650	12.00
48	560	42	800	14 00
54	735	48	1000	16.00
60	1000	52	1500	20 00

Clutches with Bronze and Self-oiling Bushings will be charged extra. In ordering clutches, specify diameter and speed of shafting, and power clutch is required to carry.

Digitized by Google

ROTARY FIRE PUMPS.



ENGRAVING No. 62.

Every mill and factory should be provided with a pump for fire protection.

The above engraving represents our Rotary Pump which contains valuable features in its construction. They are mounted on heavy cast iron bases, thus insuring perfect alignment.

The shafts are connected at both ends of the pumps by machine cut spur gears protected by covers. The shafts are large and run in babbitted bearings of unusual length. All parts are fit up with the greatest precision, the cams being ground in oil.

Digitized by Google

The pump is usually attached to the jack shaft driven by the water wheel through friction gears provided with V shaped grooves accurately fitted to work together.

When horizontal wheels are used, pumps can often be attached direct to the wheel shaft. (See engraving No. 31.)

When pumps are used only at long intervals, they should be freed from water when stopped, for which purpose a drip plug is attached to the inlet Oil should then be applied to the cams through the priming plug, after which the machine should be turned a few times, distributing the oil over the cams and effectually preventing rust and always insuring a nice working pump.

The pump should run so that the tops of the gears turn towards each other. Provision is made so that it can be driven from either end.

The suction is regularly fitted for wrought iron pipe connections, but can be fitted for cast iron or hose.

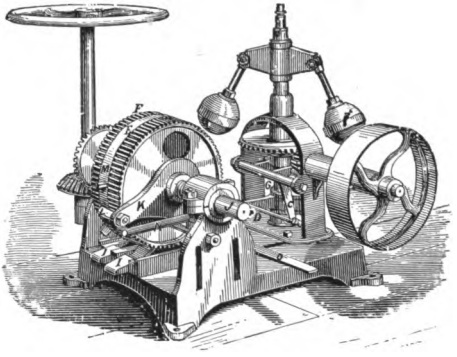
Each pump has five discharge openings. One is provided with a 2½ inch hose coupling and cap. One is threaded for wrought iron pipe of size stated in table below. The other outlets are provided with blank flanges, unless otherwise ordered. All pumps should be provided with automatic relief valves.

SIZES, CAPACITY AND PRICES.

Size.	Capacity One Rev.	Speed and Capacity per Minute for Good Fire Service.	Sizes of Pipe.		Price.	Safety Valves	
			Suc.	Dis.		Size.	Price.
No. 3	1 gal.	350 to 400 revs.—350 to 400 gals.	3 in.	2½ in.	$180 00	2 in.	$12 00
" 4	1⅝ "	300 to 350 " —500 to 580 "	5 "	4 "	250 00	3 "	18 00
" 5	2½ "	250 to 300 " —625 to 750 "	6 "	5 "	320 00	3½ "	24 00
" 6	4 "	200 to 250 " —800 to 1000 "	8 "	6 "	475 00	4 "	30 00

Digitized by Google

WATER WHEEL GOVERNOR.



ENGRAVING No. 63.

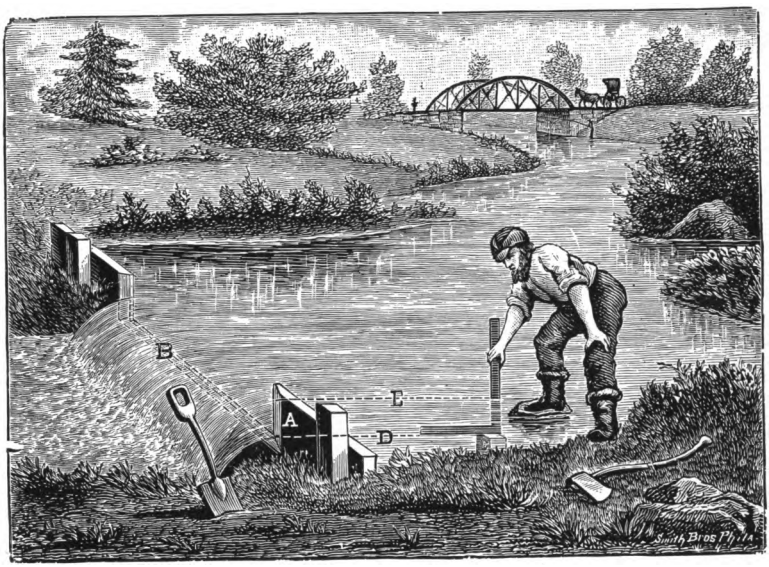
The above engraving represents one of the best mechanical water wheel governors made. There are over two thousand in use, regulating all kinds of machinery. It is made in two different styles to accommodate the machinery the Turbine is driving. In writing always state the horse power and kind of a wheel the Governor will be used on, the number of turns of the hand wheel required to open the gates full, and whether the wheel works to its full capacity.

DIRECTIONS FOR SETTING UP.

The driving pulley makes 160 revolutions per minute when running at speed and can be driven from any convenient shaft driven by the wheel, usually the jack shaft. It makes no difference which way the driving pulley turns. The top of the ratchet F turns toward the balls to open the gate and must be geared to make from three to eight turns to open gates full from the time the gate is closed until fully open. The bevel gear shown on the gate stem or hand wheel shaft will have to be placed sometimes below and sometimes above the bevel gear J on the regulator in order to turn the gate the right way. K is a nut with an arm carrying a pin which comes under a lug in the shield E and designed for a stop motion, otherwise to stop the action of the pawls, which operate to open the gate when the gate is fully open. This nut K must be brought up tight against the shoulder when the gate is open, then slip the bevel gear on the gate stem into mesh with the gear J on the regulator. These gears are always left in mesh with each other. They must be keyed, and in no case fastened with screws, which are liable to slip, and thereby disarrange the stop motion, which should be always ready to act in case of low water, or if the wheel should run below speed from any cause when the gate is fully open. The stand bolted on the side of the regulator is designed to form a bearing for the gate stem at the gears. The lever O operates a slide which is to detach the pawls from the ratchet when the gate is to be operated by hand, to start and stop the wheel; throw the end of this lever as far as possible toward the driving pulley to detach the pawls, and in the opposite direction when the regulator is to operate. The lever N is part of a friction brake, and must have weight enough placed on it to retain the ratchet in the position where the pawls place it. If the brake needs much weight it would be well to take the weight off when the gates are to be operated by hand. When setting the regulator throw out the pawls by means of the lever O, then the ratchet is free to turn by hand. A proper foundation is always desirable. If the regulator cannot be placed as represented, common sense will suggest a method.

Digitized by Google

RULE FOR MEASURING WATER BY WEIRS.



ENGRAVING No. 64.

In the improvement of water power, the first and most important facts are to ascertain the height of head and quantity of water that can be utilized.

For small streams where it is very important to know what quantity of water can be relied on, there is no better method of ascertaining this than by weir measurement.

Engraving No. 64 shows a weir. A is a board extending across stream with notch B, over which water flows, beveled on down stream side. The stake at which measurements are taken is located 4 to 8 feet from weir, on up stream side, top being on a level with top notch in weir board as per line D. When the full flow of stream is passing over the weir the depth will be the distance from line D to line E (obtained by measuring on stake). The level of water surface on down stream side of weir should not be less than 8 inches below bottom of notch B in the weir board. The length of the notch B should never be less than three to four times the depth for very small streams, and longer for larger streams. See table for weir measurements on next page.

Digitized by Google

Table Showing the Quantity of Water Passing Over Weirs in Cubic Feet per Minute.

Depth of water on weir in inch.	Cubic feet per minute passed for each foot of length of weir.	Depth of water on weir in inch.	Cubic feet per minute passed for each foot of length of weir.	Depth of water on weir in inch.	Cubic feet per minute passed for each foot of length of weir.	Depth of water on weir in inch.	Cubic feet per minute passed for each foot of length of weir.
1	4.85	4¾	50.20	8½	120.18	12½	214.32
1⅛	5.78	4⅞	52.18	8⅝	122.82	12¾	220.76
1¼	6.68	5	54.22	8¾	125.52	13	227.30
1⅜	7.80	5⅛	56.25	8⅞	128.14	13¼	233.92
1½	8.90	5¼	58.33	9	130.93	13½	240.54
1⅝	10.00	5⅜	60.42	9⅛	133 65	13¾	247.22
1¾	11.23	5½	62.55	9¼	136.43	14	254.03
1⅞	12.45	5⅝	64.68	9⅜	139.18	14¼	260.83
2	13 72	5¾	66.86	9½	141 99	14½	267.77
2⅛	15.02	5⅞	68.98	9⅝	144.80	14¾	274.70
2¼	16.36	6	71.27	9¾	147.64	15	281.72
2⅜	17.75	6⅛	73.45	9⅞	150.47	15¼	288.82
2½	19.17	6¼	75.77	10	153.35	15½	295.93
2⅝	20.63	6⅜	78 04	10⅛	156.20	15¾	303.10
2¾	22.11	6½	80.36	10¼	159.14	16	310.36
2⅞	23.63	6⅝	82.63	10⅜	162.07	16¼	317 69
3	25.20	6¾	85.04	10½	164 99	16½	325.03
3⅛	26.78	6⅞	87.43	10⅝	167.89	16¾	332.42
3¼	28.43	7	89.82	10¾	169.92	17	339.91
3⅜	30.06	7⅛	92.16	10⅞	173.90	17¼	347.45
3½	31.75	7¼	94.67	11	176.92	17½	355.02
3⅝	33.45	7⅜	97.11	11⅛	179.94	17¾	362.77
3¾	35.22	7½	99.50	11¼	182 99	18	370.34
3⅞	36.98	7⅝	102.10	11⅜	186.03	18¼	378.12
4	38.80	7¾	104 63	11½	189.13	18½	385.87
4⅛	40 63	7⅞	107.13	11⅝	192.20	18¾	393.66
4¼	42.49	8	109.74	11¾	195.32	19	401.63
4⅜	44.39	8⅛	112.31	11⅞	198.47	19¼	409.58
4½	46.29	8¼	114.91	12	201.59	19½	417.48
4⅝	48.22	8⅜	117.51	12¼	207.94	19¾	425.68

For explanation of above table and construction of Weirs see page 103.

Digitized by Google

MEASUREMENT OF LARGE STREAMS.

In streams too large to measure by weir, the quantity of water is usually determined by "float measurement." In the use of this method it is important that the float be so made that it sinks well into the water. The measurements should be taken at a point where the velocity is not too great, and where the bed of the stream is uniform. If the stream be wide, the velocity in feet per minute should be taken near the shore and in the center; the average then is the velocity of the stream.

To ascertain the cubic feet of water, multiply the depth by the width, multiply this product by the velocity in feet per minute, and the result will be the number of cubic feet flowing per minute, from which deduct 20 per cent for losses by friction, etc.

MEASUREMENT OF WATER THROUGH OPENINGS UNDER PRESSURE.

Table giving the number of cubic feet of water discharged per minute, by an orifice one inch square, under any head from 3 to 62 inches.

Head	Cubic Feet	Head	Cubic Feet	Head	Cubic Feet	Head	Cubic Feet	Head	Cubic Feet	Head	Cubic Feet
3	1.12	13	2.20	23	2.91	33	3.47	43	3.95	53	4.39
4	1.27	14	2.27	24	2.97	34	3.52	44	4.00	54	4.42
5	1.41	15	2.36	25	3.03	35	3.57	45	4.05	55	4.46
6	1.53	16	2.44	26	3.09	36	3.63	46	4.10	56	4.52
7	1.64	17	2.51	27	3.15	37	3.67	47	4.13	57	4.55
8	1.75	18	2.58	28	3.20	38	3.72	48	4.18	58	4.58
9	1.85	19	2.65	29	3.26	39	3.77	49	4.22	59	4.63
10	1.94	20	2.72	30	3.32	40	3.82	50	4.27	60	4.66
11	2.03	21	2.78	31	3.37	41	3.86	51	4.30	61	4.72
12	2.12	22	2.85	32	3.42	42	3.92	52	4.34	62	4.74

EXAMPLE, SHOWING APPLICATION OF ABOVE TABLE.

Suppose the opening to let the water on an overshot wheel be 36 inches long and the gate hoisted 2 inches; the head of water above opening 25 inches. Multiply the length, 36, by 2 (the height the gate is hoisted) and the result will be 72, the number of square inches in opening.

By referring to the above table, opposite 25-inch head will be found 3.03; this multiplied by the 72 gives 218.16, the number of cubic feet of water passing through the opening per minute.

Digitized by Google

Table Showing the Theoretical Velocity and Discharge in Cubic Feet Through an Orifice of One Square Inch Issuing Under Heads Varying from 1 to 100 Feet.

Head in feet.	Theoretical discharge in Cubic Feet per Minute	Theoretical velocity in feet per Minute	Head in feet.	Theoretical discharge in Cubic Feet per Minute	Theoretical velocity in feet per Minute	Head in feet.	Theoretical discharge in Cubic Feet per Minute	Theoretical velocity in feet per Minute
1	3 34	481 2	35	19 77	2847 6	69	27.74	3997.1
2	4.73	680.4	36	20.05	2887.2	70	27.94	4021.1
3	5 79	833 4	37	20.33	2926.8	71	28.14	4054 5
4	6 63	962.4	38	20.60	2966.4	72	28.34	4283 0
5	7.47	1075 8	39	20.87	3004.8	73	28 53	4111.3
6	8.18	1178.4	40	21.13	3043.2	74	28.73	4139.4
7	8.84	1273 2	41	21.38	3081.1	75	28.93	4165.2
8	9 45	1360.8	42	21.64	3118 5	76	29.11	4194 9
9	10 02	1443 6	43	21.90	3156 4	77	29.30	4222 4
10	10 57	1521.6	44	22.15	3191 8	78	29 49	4249 8
11	11 08	1595.0	45	22.40	3227 8	79	29.68	4265 9
12	11.57	1666 8	46	22.65	3263.6	80	29.87	4303 6
13	12 05	1734.6	47	22 89	3298.9	81	30.06	4330.8
14	12.50	1800.6	48	23.14	3333.8	82	30.24	4357.4
15	12 94	1863 6	49	23.38	3368.4	83	30.42	4383.6
16	13.37	1924 8	50	23 61	3402 5	84	30.61	4410.2
17	13.78	1984 2	51	23 85	3436 4	85	30.79	4436.4
18	14.18	204 8	52	24.08	3469.9	86	30.97	4462 4
19	14 57	2097 6	53	24.31	3503.1	87	31.15	4488.2
20	14 95	2152 2	54	24.54	3536.0	88	31.33	4514 0
21	15 31	2205 0	55	24.76	3568.6	89	31.50	4539 5
22	15.67	2256.6	56	24.99	3600 9	90	31.68	4565 0
23	16 02	2307 6	57	25.21	3632.9	91	31.86	4590 3
24	16 37	2357 4	58	25.43	3664 6	92	32.04	4615 4
25	16 71	2406.0	59	25.65	3696.1	93	32.20	4640.5
26	17.04	2453.4	60	25 87	3727.3	94	32.38	4665.3
27	17 36	2500.2	61	26.08	3758.2	95	32 55	4690.1
28	17 68	2545 8	62	26 29	3788.9	96	32.72	4714 7
29	17 99	2590 8	63	26 51	3819.3	97	32.89	4739 2
30	18 30	2635 8	64	26 72	3849.6	98	33.06	4763.5
31	18 60	2679 0	65	26 92	3879.5	99	33.23	4787.8
32	18 90	2722.2	66	27.13	3909 2	100	33.40	4812 0
33	19 20	2764.2	67	27.33	3938 7	...	.....	.....
34	19.40	2806 2	68	27.54	3968.4	...	.....	.....

Digitized by Google

Loss of Head in One Hundred Feet Length of Pipe at Different Velocities.

Diameter of Pipe.	Cubic feet per minute at one foot per second velocity	1 Foot per Second.	1½ Ft. per Second.	2 Feet per Second.	3 Feet per Second.	4 Feet per Second.	5 Feet per Second.	6 Feet per Second.	7 Feet per Second
3″	2.95	.186	476	.700	1.507	2.600	3.937	5.598	7.472
6	11.75	c855	.213	.324	.702	1.214	1.843	2 619	3 003
9	26.50	.0543	.1422	.2053	.4440	.7690	1.170	1.6650	2.4500
12	47 10	.040	.0983	.1480	.3206	.55c0	.8437	1.1925	1.5925
15	73 50	.0295	.0754	.1170	.2430	.4240	.6500	.9190	1.2250
18	106	0237	.0600	.0900	.1944	.3400	.5208	.7425	.9975
21	144	.0193	.0492	.0729	.16 7	.2800	.4286	.6043	.8150
24	188	.0166	.0413	.0625	.1350	.2350	.3641	.5175	.6891
27	238	.0139	.0341	.0533	.1175	.2044	.3125	.4460	.5990
30	294	.0123	.0310	.0470	.1013	.1760	.2725	.3870	.5230
35	424	.0096	.0243	.0367	.0787	.1383	.2135	.3038	.4073
42	577	.0075	.0189	.0286	.0630	.1114	.1571	.2443	.3280
48	752	.0062	.0158	.0240	.0529	.0925	.1438	.2042	.2756
54	954	.0052	.0133	.0202	.0449	.0778	.1198	.1700	.2300
60	1176	.0044	.0113	.0173	.0383	.0667	.1062	.1458	.1972
66	1425	.0039	.0100	.0153	.0338	.0591	.0909	.13c9	.1755
72	1696	.0035	.0089	.0137	.0301	.0530	.0815	.1162	.1698
78	1991	.0031	.0079	.0122	.0263	.0476	.0731	.1038	.1382
84	2308	.0028	.0072	.0110	.0243	.0426	.0656	.0939	.1256
90	2650	0025	.0063	.009$	.0218	.0382	.0590	.0840	.1139
96	3008	.0022	.0055	.0088	.0196	.0342	.0531	.0754	.1018
102	3406	.0021	.0046	.00$3	.0183	.0334	.0511	.0731	.1000
108	38.6	.0019	.0043	.0075	.0172	.0307	.0482	.0693	.0964
120	4704	.0018	.0040	.0070	.0160	.0285	.0446	.0643	.0876
132	5702	.0017	.0038	.0067	.0154	.0276	.0430	.0619	.0851
144	6784	0015	.0032	0060	.0131	.0241	.0374	.0523	.0735

Digitized by Google

WEIGHT OF A CUBIC FOOT OF SUBSTANCES.

Names of Substances.	AVERAGE WEIGHT, LBS.
Anthracite coal, solid, of Pennsylvania,	93
Anthracite coal, broken, loose,	54
Anthracite coal, moderately shaken,	58
Anthracite coal, heaped bushel, loose,	(80)
Ash, American white, dry,	38
Asphaltum,	87
Brass, (Copper and Zinc,) cast,	504
Brass, rolled,	524
Brick, best pressed,	150
Brick, common hard,	125
Brick, soft, inferior,	100
Brickwork, pressed brick,	140
Brickwork, ordinary,	112
Cement, hydraulic, ground, loose, American, Rosendale,	56
Cement, hydraulic, ground, loose, American, Louisville,	50
Cement, hydraulic, ground, loose, English, Portland,	90
Cherry, dry,	42
Chestnut, dry,	41
Coal, bituminous, solid,	84
Coal, bituminous, broken, loose,	49
Coal, bituminous, heaped bushel, loose,	(74)
Coke, loose, of good coal,	27
Coke, loose, heaped bushel,	(38)
Copper, cast,	542
Copper, rolled,	548
Earth, common loam, dry, loose,	76
Earth, common loam, dry, moderately rammed,	95
Earth, as a soft, flowing mud,	108
Ebony, dry,	76
Elm, dry,	35
Flint,	162
Glass, common window,	157
Gneiss, common,	168
Gold cast, pure, or 24 carat,	1204
Gold, pure, hammered,	1217
Granite,	170
Gravel, about the same as sand, which see.	
Hemlock, dry,	25
Hickory, dry,	53
Hornblende, black,	203
Ice,	58.7
Iron, cast,	450
Iron, wrought, purest,	485
Iron, wrought, average,	480
Ivory,	114
Lead,	711
Lignum Vitae, dry,	83
Lime, quick, ground, loose, or in small lumps,	53
Lime, quick, ground, loose, thoroughly shaken,	75

Digitized by Google

WEIGHT OF SUBSTANCES—Continued.

Names of Substances.	AVERAGE WEIGHT LBS.
Lime, quick, ground, loose, per struck bushel,	(66)
Limestone and Marbles,	168
Limestone and Marbles, loose, in irregular fragments,	96
Mahogany, Spanish, dry,	53
Mahogany, Honduras, dry,	35
Maple, dry,	49
Marbles,—see Limestone.	
Masonry, of granite or limestone, well dressed,	165
Masonry, of mortar rubble,	154
Masonry, of dry rubble, (well scabbled),	138
Masonry, of sandstone, well dressed,	144
Mercury, at 32 degrees Fahrenheit,	849
Mica,	183
Mortar, hardened,	103
Mud, dry, close,	80 to 110
Mud, wet fluid, maximum,	120
Oak, live, dry,	59
Oak, white, dry,	52
Oak, other kinds,	32 to 45
Petroleum,	55
Pine, white, dry,	25
Pine, yellow, Northern,	34
Pine, yellow, Southern,	45
Platinum,	1342
Quartz, common, pure,	165
Rosin,	69
Salt, coarse, Syracuse, N. Y.,	45
Salt, Liverpool, fine, for table use,	49
Sand, of pure quartz, dry, loose,	90 to 106
Sand, well shaken,	99 to 117
Sand, perfectly wet,	120 to 140
Sandstones, fit for building,	151
Shales, red or black,	162
Silver,	655
Slate,	175
Snow, freshly fallen,	5 to 12
Snow, moistened and compacted by rain,	15 to 50
Spruce, dry,	25
Steel,	490
Sulphur,	125
Sycamore, dry,	37
Tar,	62
Tin, cast,	459
Turf or Peat, dry, unpressed,	20 to 30
Walnut, black, dry,	38
Water, pure rain or distilled, at 60 degrees Fahrenheit,	62 1-3
Water, sea,	64
Wax, bees,	60.5
Zinc or Spelter,	437

Green timbers usually weigh from one-fifth to one-half more than dry.

Digitized by Google

Table of Approximate Numbers for Various Purposes.

Diameter of a circle × 3.1416 = circumference.
Diameter of a circle × .8862 = side of an equal square.
Diameter of a circle × .7071 = side of an inscribed square.
Square of a diameter × .7854 = area of circle.
Circumference of a circle × .31831 = diameter.
Side of a square × 1.128 = diameter of equal circle.
Square root of an area × 1.12837 = diameter of equal circle.
Square of the diameter of a sphere × 3 1416 = convex surface
Cube of the diameter of a sphere × .5236 = solidity.
Diameter of a sphere × .806 = dimensions of equal cube.
Diameter of a sphere × .6667 = length of equal cylinder.
Square inches × .09695 = square feet.
Cubic inches × 00058 = cubic feet.
Cubic feet × 03704 = cubic yards.
Cylindrical inches × .0004546 = cubic feet.
Cylindrical feet × .02909 = cubic yards.
Cubic inches × .003607 = imperial gallons.
Cubic feet × .6232 = imperial gallons.
Cylindrical inches × 002832 = imperial gallons.
Cylindrical feet × 4 895 = imperial gallons.
183.346 circular inches = 1 square foot.
2200 cylindrical inches = 1 cubic foot.
Avoirdupois pounds × .009 = cwts.
Avoirdupois pounds × .00045 = tons.
Lineal feet × .00019 = statute miles.
Lineal yards × 000568 = statute miles.

Digitized by Google

Weight, Strength and Horse Power that can be Transmitted Safely with the Best Transmission Manilla Rope.

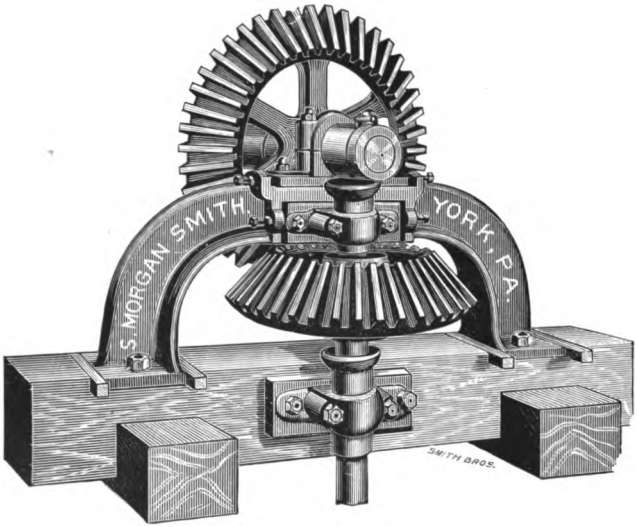
Diameter of rope in inches.	Horse Power at 1,000 feet velocity per minute.	Horse Power at 2,000 feet velocity per minute.	Horse Power at 3,000 feet velocity per minute.	Horse Power at 4,000 feet velocity per minute.	Horse Power at 5,000 feet velocity per minute.	Effective working tension in lbs.	Strength of Manilla rope in lbs.	Weight of Manilla Rope in lbs.	Weight of tarred hemp rope in lbs.	Diameter of the smallest pulleys at centre of rope in inches.
5/8	1.21	2 42	3 63	4.84	6.05	40	4,000	0.133	0.166	18
3/4	1 81	3.62	5 43	7.24	9.05	60	5,000	0.163	0.208	22
7/8	2.47	4 94	7 41	9.88	12.35	82	7.500	0.233	0.316	26
1	3.26	6.52	9.78	13 04	16.30	108	9.000	0.283	0.375	30
1 1/4	5 05	10.10	15 15	20.20	25.25	167	14,000	0.450	0 583	37
1 1/2	7.30	14.16	21.90	29.20	36.50	242	20,250	0.651	0.850	45
1 3/4	10.00	20.00	30 00	40.00	50.00	330	30,250	0.970	1.296	52
2	13.00	26 00	39.00	52.00	65.00	430	36,000	1.130	1.550	60
2 1/4	16.45	32.90	49.35	65.80	82.25	543	49,000	1.533	2.075	68
2 1/2	20.31	40 62	60.93	81.24	101.55	670	56,250	1.843	2.341	75
3	29.25	58.50	87 75	117.00	146 25	965	81,000	2.620	3.383	90
3 1/2	39.82	79.64	119 46	159 28	199.10	1314	100,000	3.053	4.603	105

Horse Power of Finished Iron and Steel Shafting, as Prime and Second Movers Carrying Pulleys or Gears. Bearings 8 Feet from Centre to Centre for a Given Diameter and Speed.

Diameter of Shaft in inches.	Revolutions per minute.	H. P. Prime Movers.	H. P. Second Movers.	Diameter of Shaft in inches.	Revolutions per minute.	H. P. Prime Movers.	H. P. Second Movers.
1 7/16	100		3.75	4 7/16	100	72.00	102 66
1 1/2	100		5.95	4 1/2	100	85.00	120 67
1 15/16	100	6.40	8.88	4 15/16	100	100.00	140 63
2 3/16	100	8.10	12.65	5 3/16	100	115.00	162.71
2 7/16	100	12.50	17.35	5 7/16	100	133.00	186.97
2 1/2	100	16.00	23.10	5 1/2	100	152.00	214 54
2 15/16	100	20.00	30 00	5 15/16	100	172.00	242 52
3 3/16	100	27 00	38.13	6 7/16	100	221.00	308.09
3 7/16	100	34 00	47.63	6 1/2	100	276.00	384 54
3 1/2	100	42.00	58 58	7 7/16	100	339.00	472.67
3 15/16	100	51.00	71.11	7 1/2	100	412.00	573.38
4 3/16	100	61.00	86 57				

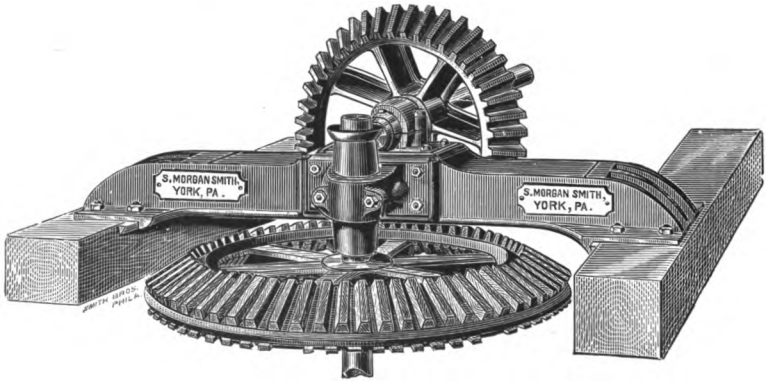
Digitized by Google

IRON TRUSSES FOR HEAVY GEARS.



ENGRAVING No. 65.

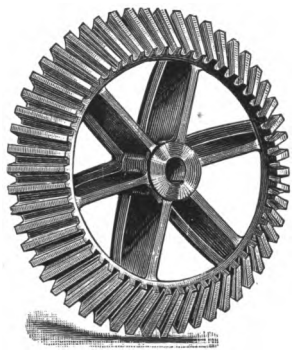
The superiority of iron trusses for the support of heavy gearing is evident to all, as they form a steady and positive bearing, which otherwise would cause great wear of the gears. The above cut is one of the many styles of our trusses supported by wooden girders. We, however, are prepared to furnish complete outfits of gears and trusses, with iron girders.



ENGRAVING No. 66.

The above cut shows a straight iron truss, supporting a heavy pair of bevel mortise gears. It is securely bolted to timbers, and prevents the wearing of the cogs occasioned by the too light and often poorly constructed wooden bridgetrees.

Digitized by Google



BEVEL MORTISE WHEELS AND PINIONS.

No. of Pattern.	Diameter.	No. of Cogs.	Pitch.	Face.	Backing.	Weight.	Proportion.
†233	9. 7 2/100	74	4½	15	15¼	6300	1 to 2.741
	3. 2 76/100	27	4½	15	3	3000	
†234	7. 1 98/100	60	4½	15	11	4650	1 to 2.4
	2. 11 90/100	25	4½	15	4	1760	
†235	7. 1 98/100	60	4½	15	11	4875	1 to 1.765
	4. 0 77/100	34	4½	15	4	2485	
†248	8. 3 33/100	78	4	14	13½	5850	1 to 2.6
	3. 2 2/100	30	4	14	2	1700	
†249	10. 0 97/100	95	4	16	19	8550	1 to 2.969
	3. 4 81/100	32	4	16	2	2195	
†250	7. 0 66/100	66	4	16	13½	4954	1 to 2.64
	2. 7 85/100	25	4	16	3	1405	
†251	5. 6 7/10	52	4	14	12½	3840	1 to 1.49
	3. 8 56/100	35	4	14	4½	2110	
†252	7. 0 66/100	66	4	12	12	4340	1 to 3.0
	2. 4 1/10	22	4	12	2	850	
†253	5. 11 34/100	56	4	12	14½	3400	1 to 1.555
	3. 9 30/100	36	4	12	6	1925	
†254	6. 6 98/100	62	4	12	11⅜	3790	1 to 2.48
	2. 7 85/100	25	4	12	3½	1235	
†255	7. 7 70/100	72	4	14	12	4650	1 to 2.483
	3. 1 27/100	29	4	14	3½	1640	
†256	7 11 61/100	75	4	14	12	5150	1 to 2.027
	3 11 17/100	37	4	14	3½	2250	

See page 118 for price list for filling and cutting gears.

Digitized by Google

BEVEL MORTISE WHEELS AND PINIONS—Continued.

No. of Pattern.	Diameter.	No. of Cogs.	Pitch.	Face.	Backing	Weight.	Proportion.
†257	6. 1 88/100	58	4	12	7	3350	1 to 1.933
	3. 2 27/100	30	4	12	5	1350	
†258	4. 0 44/100	38	4	14	10	2175	1 to 1.118
	3. 9 35/100	34	4	14	4½	1560	
†259	4. 2 98/100	40	4	14	7	2310	1 to 1.026
	4. 1 78/100	39	4	14	11	2180	
319	8. 2	88	3½	14	14 5/8	5060	1 to 3.384
	2. 5	26	3½	14	1⅜	900	
320	6. 11 58/100	75	3½	14	14½	3775	1 to 2.5
	2. 9 43/100	30	3½	14	1½	1100	
†324	5. 11 ½	64	3½	12	12½	3075	1 to 2.782
	2. 1 ¾	23	3½	12	2½	798	
325	5. 6 ⅞	60	3½	12	10	2460	1 to 2 069
	2. 8 ⅜	29	3½	12	2½	940	
†326	5. 9 10/100	62	3½	12	10½	2920	1 to 2.138
	2. 8 37/100	29	3½	12	3½	1080	
†327	4. 5 52/100	48	3½	12	8 5/8	2125	1 to 1.263
	3. 6 39/100	38	3½	12	5	1475	
†328	5. 4 65/100	58	3½	12	9	2700	1 to 1.812
	2. 11 76/100	32	3½	12	3	1250	
†329	5. 6 88/100	60	3½	12	8	3700	1 to 1.5
	3. 8 60/100	40	3½	12	5½	1800	
†336	6. 8 11/100	78	3¼	11	11½	3390	1 to 2.689
	2. 6 6/100	29	3¼	11	3	965	
†337	6. 8 11/100	78	3¼	11	12½	3325	1 to 2.44
	2. 9 15/100	32	3¼	11	3	1160	
†339	3. 11 78/100	50	3	12	8	1445	1 to 2.173
	1. 10	23	3	12	1½	520	
340	4. 3 ½	54	3	14	8½	1320	1 to 1.149
	3. 8 ¾	47	3	14	5	1155	
†341	4. 3 6/10	54	3	12	7⅞	1595	1 to 1.543
	2. 9 7/16	35	3	12	3	870	
†342	4. 3 6/10	54	3	12	7⅞	1750	1 to 1.41
	3. 1 28/100	39	3	12	3½	1080	
†343	6. 0	76	3	10	9	2240	1 to 2.923
	2 0 80/100	26	3	10	2	635	
344	5 3 1/16	66	3	10	9⅝	1890	1 to 1.886
	2. 9 7/16	35	3	10	2¼	750	
345	5. 0 3/16	63	3	10	9½	1600	1 to 3.0
	1. 8 1/16	21	3	10	1½	360	
†346	3. 6 50/100	44	3	10	4½	1100	1 to 1.023
	3. 5 10/100	43	3	10	3	1025	
347	5. 8 78/100	72	3	12	9⅜	2260	1 to 2.88
	1 11 93/100	25	3	12	1⅝	590	

See page 118 for price list for filling and cutting gears.

Digitized by Google

BEVEL MORTISE WHEELS AND PINIONS—Continued.

No. of Pattern.	Diameter.	No. of Cogs.	Pitch.	Face.	Backing.	Weight.	Proportion.
†348	3.91 87/100	48	3	12	6½	1530	1 to 1.09
	3 61 55/100	44	3	12	4¼	1240	
†349	3.11¼	50	3	10	7	1270	1 to 1.25
	3.21 2/16	40	3	10	3½	875	
†350	4.41 55/100	55	3	12		1950	1 to 1.964
	2.21 79/100	28	3	12	2	800	
†351	5.83/4	72	3	10	9¼	2225	1 to 1.756
	3.31 3/16	41	3	10	2¾	1100	
353	6.21/2	78	3	8	9½	1836	1 to 2.0
	3.11/4	39	3	8	5	688	
354	5.71 82/100	71	3	9	10¼	1778	1 to 3.737
	1.61 23/100	19	3	9	1⅞	350	
370	6.81/2	88	2⅞	6¼	9½	1112	1 to 4.4
	1.61/4	20	2⅞	6¼	2½	224	
†372	3.11 3/10	54	2¾	10	7	1280	1 to 1.038
	3.91 55/100	52	2¾	10	4	1140	
†373	5.31 1/16	72	2¾	9	8¼	1750	1 to 2.057
	2.65/8	35	2¾	9	2⅛	725	
†373½	5.31/2	72	2¾	9	8¼	1750	1 to 2.387
	2.31/4	31	2¾	9	2	700	
†374	2.51 80/100	34	2¾	8	6¼	448	1 to 1.36
	1.91 94/100	25	2¾	8	3	346	
380	7.00	96	2¾	8	11¼	2125	1 to 3.43
	2.01/2	28	2¾	8	⅞	425	
*383	6.11	96	2¾	6	10¼	1720	1 to 4.8
	1.51/2	20	2¾	6	¾	340	
*384	6.4	88	2¾	7	9¼	1675	1 to 2.93
	2.21/4	30	2¾	7	2½	435	
*400	3.03/8	44	2⅝	7½	5¾	570	1 to 1.048
	2.11	42	2⅝	7½	4	550	
†407	5.61 22/100	83	2½	8	9	1600	1 to 2.515
	2.21 30/100	33	2½	8	2⅜	485	
†408	5.01 50/100	76	2½	8	11	1550	1 to 2.923
	1.81 74/100	26	2½	8	1½	415	
†409	5.01 50/100	76	2½	8	8½	1380	1 to 2.815
	1.91 53/100	27	2½	8	2	315	
†410	5.11 5/8	90	2½	8	9¼	1525	1 to 2.0
	2.11 13/16	45	2½	8	2⅝	650	
†411	3.11¾	60	2½	9	6	1210	1 to 1.5
	2.71 12/16	40	2½	9	2½	620	
412	3.11¾	60	2½	8	7	715	1 to 2.222
	1.9	27	2½	8	1⅝	310	
†413	3.65/8	54	2½	4	6	379	1 to 2 842
	1.31/8	19	2½	4	1½	88	
†414	3.13/4	60	2½	8	6½	1015	1 to 1.875
	2.11/2	32	2½	8	2½	460	

See page 118 for price list for filling and cutting gears.

Digitized by Google

BEVEL MORTISE WHEELS AND PINIONS—Continued.

No. of Pattern.	Diameter.	No. of Cogs.	Pitch	Face.	Backing.	Weight.	Proportion.
*415	7.9	120	2½	6½	10	2100	1 to 3.077
	2.6¼	39	2½	6½	3	385	
*416	6.6	102	2½	7	10½	1320	1 to 2.62
	2.6	39	2½	7	2¾	360	
†427	5.11 63/100	100	2¼	7	8½	1570	1 to 4.166
	1.51 24/100	24	2¼	7	1⅜	275	
†428	4.0	67	2¼	7	6½	784	1 to 2.66
	1.51 95/100	25	2¼	7	1½	235	
429	2.11 13/16	50	2¼	8	4¼	500	1 to 1.163
	2.6 5/8	43	2¼	8	1¾	400	
†430	4.0 3/4	68	2¼	8	6	970	1 to 2.
	2.0 3/8	34	2¼	8	1 5/8	365	
†433	2.11 15/16	50	2¼	8	4¼	625	1 to 1.02
	2.11 1/16	49	2¼	8	3⅛	575	
†434	2 3/4	38	2¼	7	2⅜	330	1 to 1.
	2.3 1/4	38	2¼	7	3 5/8	300	
†435	2.11 3/4	50	2¼	8	4½	575	1 to 1.428
	2.1 3/16	35	2¼	8	2¾	355	
†436	2.10 7/8	48	2¼	7	4⅛	512	1 to 1.2
	2.4 5/8	40	2¼	7	2½	382	
438	5.5 8/8	92	2¼	6	7½	1030	1 to 1.957
	2.9 1/16	47	2¼	6	2	455	
†445	2.11 3/100	55	2	6	5½	400	1 to 2.2
	1.3 96/100	25	2	6	1½	125	
†446	2.11 67/100	56	2	6	7	510	1 to 2.074
	1.5 23/100	27	2	6	1¾	180	
†447	2.11 67/100	56	2	6	5½	458	1 to 1.514
	1.11 58/100	37	2	6	2⅜	254	
448	4.5 7/16	84	2	6	7¼	825	1 to 3.111
	1.5 3/16	27	2	6	1½	160	
†449	1.8 3/8	32	2	6	3½	163	1 to 1.032
	1.7 3/4	31	2	6	2½	135	
†450	1.5 82/100	28	2	5	3½	120	1 to 1.
	1.5 82/100	28	2	5	2½	130	
†451	3.7 31/100	68	2	5	6¼	670	1 to 4.
	.10 88/100	17	2	5	½	85	
†452	2.6 1/2	48	2	6	5	230	1 to 2.087
	1.2 5/8	23	2	6	5/8	105	
†453	2.1 1/2	40	2	6	3⅜	230	1 to 1.081
	1.11 1/2	37	2	6	2⅛	180	

See page 118 for price list for filling and cutting gears.

Digitized by Google

BEVEL MORTISE WHEELS AND PINIONS—Continued.

No. of Pattern.	Diameter.	No. of Cogs.	Pitch.	Face.	Backing.	Weight.	Proportion.
454	2.6 9/16	48	2	6	3 1/2	250	1 to 1.02
	2.5 15/16	47	2	6	2 5/8	240	
†455	4.0 3/8	76	2	6	5 1/2	510	1 to 1.948
	2.0 3/16	39	2	6	1 7/8	245	
*456	6.0 3/4	114	2	6	9	950	1 to 2.
	3.0 1/4	57	2	6	3 1/2	425	
457	1.10 15/16	36	2	6	2	185	1 to 1.333
	1.5 1/4	27	2	6		105	
458	2.4	44	2	5	4 1/4	250	1 to 1.419
	1.7 3/4	31	2	5	2 5/8	140	
*475	3.0	60	1 7/8	5 1/2	4 1/2	300	1 to 1.621
	1.10 1/4	37	1 7/8	5 1/2	2 5/8	200	
480	2.0 1/2	44	1 3/4	5	3 7/8	150	1 to 1.913
	1.0 13/16	23	1 3/4	5	1	65	
481	2.7 3/16	56	1 3/4	5	3 7/8	265	1 to 1.272
	2.0 1/2	44	1 3/4	5	2 1/2	175	
*483	5.0	108	1 3/4	6 1/2	6 1/8	745	1 to 1.714
	2.11 1/4	63	1 3/4	6 1/2	2 3/8	340	
*484	5.0	108	1 3/4	4 1/2	6 1/4	560	1 to 2.77
	1.9 3/4	39	1 3/4	4 1/2	2 1/8	180	
490	2.6 9/16	64	1 1/2	4 1/2	5/8	150	1 to 4 0
	7 5/8	16	1 1/2	4 1/2	1/2	40	
*491	1.8 1/4	42	1 1/2	4	3 1/2	90	1 to 2.0
	.10 1/8	21	1 1/2	4	1 1/8	50	
†492	1.3 5/16	32	1 1/2	3 1/2	3 1/2	69	1 to 1.0
	1.3 5/16	32	1 1/2	3 1/2	2	54	
†493	3.3 64/100	83	1 1/2	4	5 1/4	310	1 to 5.928
	.6 74/100	14	1 1/2	4	3/8	40	
†494	1 9 3/16	44	1 1/2	4	4	195	1 to 1.518
	1.3 35/100	29	1 1/2	4	2	90	

See page 118 for price list for filling and cutting gears.

We employ a large force of pattern makers and are continually making new gears. If you do not find what you want in the above list, write us, specifying your requirements, and we will take pleasure in quoting prices on gears adapted to your location.

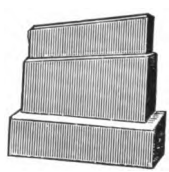
Digitized by Google

MACHINE CUT GEARING.

Among the many large and special tools in our shops are Gear Cutting Machines.

To be able to accommodate our customers with large as well as small cut gearing, we have had Mr. Gleason, the patentee, build for us machines of special size—one being of the largest he has yet constructed. We are therefore prepared to cut spur gearing with iron or wooden cogs of any size wanted, and bevel and miter gearing, wood or iron cogs—as large as 9 feet diameter, and wide as 24 inches on the face. The machines cut the cogs to a proper shape, and space them to mathematical correctness.

PRICE LIST FOR FILLING AND CUTTING GEARS.



Face of Cogs	5	6	7	8	9	10	12	14	16
Price of Cog, each	.12	.14	.16	.18	.20	.25	.40	.55	.75
Cogging Mortise Wheels per Cog, including Cog.	45	50	60	70	80	90	1.10	1.30	1.50
Dressing Iron Pinion teeth on both sides, per tooth.	60	70	75	85	90	1.05	1.50	1.65	2.20

We keep on hand a large and well seasoned stock of Maple Cog Wood, and with our improved gear cutting machines can furnish mortise gears of the most approved design.

Digitized by Google

TABLE OF EQUIVALENTS.

Tables of Equivalents of United States Weights and Measures in corresponding Metric denominations :

WEIGHTS.

1 Grain	is equivalent to	64.79892	Milligrams
1 Troy Ounce	"	31.10348	Grams
1 Avoirdupois Ounce	"	28.34953	Grams
1 Avoirdupois Pounds	"	.45359	Kilogram
1 Net Ton of 2,000 Pounds	"	.90718	Tonne
1 Gross Ton of 2,240 Pounds	"	1.01605	Tonnes

LINEAR MEASURE.

$\frac{1}{64}$ of an inch	is equivalent to	.39688	Millimeter
1 Inch	"	2.54001	Centimeters
1 Foot	"	3.04801	Meter
1 Yard	"	9 14402	Meter
1 Statute Mile	"	1.60935	Kilometers
1 Nautical Mile	"	1.85325	Kilometers

SQUARE MEASURE.

1 Square Inch	is equivalent to	6.45163	Square Centimeters
1 Square Foot	"	.09290	Square Meter
1 Square Yard	"	.83613	Square Meter
1 Acre	"	.40470	Hectare
1 Square Mile	"	2 59000	Square Kilometers

CUBIC MEASURE.

1 Cubic Inch	is equivalent to	16.38716	Cubic Centimeters
1 Cubic Inch	"	.01639	Cubic Decimeter
1 Cubic Foot	"	.02832	Cubic Meter
1 Cubic Yard	"	.76456	Cubic Meter

CAPACITY MEASURE.

1 Liquid Quart	is equivalent to	.94636	Liter
1 Gallon	"	3 78543	Liters
1 Gallon	"	.00379	Cubic Meter
1 Bushel	"	.35239	Hectoliter
1 Fluid Drachm	"	3.69671	Milliliters or Cubic Centimeters
1 Fluid Ounce	"	29 57370	Milliliters or Cubic Centimeters

MISCELLANEOUS.

1 Pound per Lineal Ft.	is equivalent to	1.48816	Kilograms per Lineal Meter
1 Pound per Square In.	"	.07031	Kilograms per Sq. Centimeter
1 Pound per Square Ft.	"	4.88241	Kilograms per Square Metre
1 Pound per Cubic Ft.	"	16.01837	Kilograms per Cubic Meter
1 Foot Pound	"	.13826	Kilogrammeter
1 United States H. P.	"	1.01387	Metric Horse Power

Digitized by Google

VELOCITY OF WATER.

Table giving velocity of water in feet per second, and the cubic feet of water per minute, to develop one horse power at 80 per cent duty under heads from 1 to 108 feet.

Head.	Velocity.	Cubic Feet.	Head.	Velocity.	Cubic Feet.	Head.	Velocity.	Cubic Feet.
1	8.02	661.765	37	48.78	17.886	73	68.53	9.065
2	11.34	330.883	38	49.44	17.415	74	69.00	8.943
3	13.89	220.589	39	50.09	16.968	75	69.46	8.822
4	16.04	165.441	40	50.72	16.544	76	69.92	8.707
5	17.92	132.353	41	51.35	16.141	77	70.38	8.594
6	19.65	110.294	42	51.98	15.756	78	70.84	8.484
7	21.22	94.538	43	52.59	15.390	79	71.29	8.377
8	22.68	82.720	44	53.20	15 040	80	71.74	8.272
9	24.06	73.529	45	53.80	14.706	81	72.19	8.170
10	25.36	66.177	46	54.40	14.368	82	72.63	8.070
11	26.60	60.160	47	54 99	14.080	83	73.07	7.973
12	27.78	55.147	48	55 57	13.787	84	73.51	7.878
13	28.92	50.905	49	56.14	13.505	85	73.95	7.785
14	30 01	47.269	50	56.71	13.236	86	74.38	7.695
15	31.06	44.118	51	57.27	12.976	87	74.81	7.606
16	32.08	41.360	52	57.84	12.726	88	75.24	7.520
17	33 07	38.927	53	58.39	12 486	89	75.67	7.436
18	34 03	36.765	54	58.93	12.255	90	76.09	7.353
19	34 96	34.830	55	59.48	12 032	91	76.51	7.272
20	35.87	33.088	56	60.01	11.817	92	76.93	7.193
21	36.75	31.513	57	60.56	11.610	93	77.35	7.116
22	37.61	30.080	58	61.08	11.410	94	77.76	7.040
23	38.46	28.772	59	61.61	11.216	95	78.18	6.966
24	39.29	27.574	60	62.12	11.029	96	78.59	6 893
25	40 10	26.471	61	62.71	10.849	97	79.00	6.822
26	40.89	25.453	62	63.15	10.674	98	79.40	6.753
27	41.67	24.510	63	63 66	10 504	99	79.81	6 685
28	42.44	23.634	64	64.16	10.340	100	80.22	6.618
29	43.19	22.819	65	64.66	10 181	101	80.61	6.552
30	43 93	22.059	66	65 16	10 027	102	81.01	6.487
31	44.65	21.347	67	65.65	9 877	103	81.40	6.425
32	45.37	20.680	68	66.14	9.732	104	81.80	6.363
33	46.07	20.053	69	66 62	9 591	105	82.19	6.303
34	46 77	19 464	70	67.11	9 454	106	82.58	6.243
35	47.45	18.908	71	67.58	9.321	107	82.97	6.185
36	48.12	18.382	72	68.06	9.191	108	83.35	6.127

Digitized by Google

WEIGHT OF ONE FOOT IN LENGTH OF FLAT ROLLED IRON.

Width in inches.	THICKNESS IN INCHES.											
	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
1	.21	.42	.63	.84	1.05	1.26	1.47	1.68	2.11	2.53	....	....
1 1/4	.26	.53	.79	1.05	1.32	1.58	1.84	2.11	2 63	3.16	3.68	4.21
1 1/2	.32	.63	.95	1.26	1.58	1.90	2.21	2.53	3.16	3.79	4.42	5.05
1 5/8	.34	.68	1.03	1.37	1.71	2.05	2.39	2.74	3.42	4.11	4.79	5.47
1 3/4	.37	.74	1.11	1.47	1.84	2.21	2 58	2.95	3 68	4.42	5.16	5.89
2	.42	.84	1.26	1.68	2.11	2.53	2.95	3 37	4.21	5.05	5.89	6 74
2 1/4	.47	.95	1.42	1.90	2.37	2.84	3.32	3.79	4.74	5.68	6.83	7.58
2 1/2	.53	1.05	1.58	2.11	2.63	3.16	3.63	4.21	5.26	6.32	7.37	8.42
3	.63	1.26	1.90	2.53	3.16	3.79	4.42	5.05	6.32	7.58	8.84	10.10
3 1/2	.74	1.47	2.21	2.95	3.68	4.42	5.16	5 89	7.37	8 84	10.32	11.79
4	.84	1.68	2 53	3 37	4.21	5.05	5.89	6.74	8.42	10 10	11.79	13.47
4 1/2	.95	1.90	2.84	3.79	4.74	5.68	6.63	7.58	9.47	11.38	13.26	15 16
5	1.05	2.11	3.16	4.21	5.26	6.32	7.36	8 42	10.53	12 63	14 74	16 84
5 1/2	1.16	2.32	3.47	4.63	5.79	6.95	8.10	9.26	11.58	13 89	16.21	18 52
6	1.26	2.53	3.79	5.05	6.32	7.58	8.84	10.10	12.63	15.16	17.68	20.21
12	2.52	5.06	7.58	10 10	12.64	15.16	17 68	20.20	25.26	30 32	35 36	40 42

WEIGHT PER FOOT OF ROUND AND SQUARE IRON.

Diameter in inches.	Square Bars.	Round Bars.	Diameter in inches.	Square Bars.	Round Bars.	Diameter in inches.	Square Bars.	Round Bars	Diameter in inches.	Square Bars.	Round Bars.
3/16	.117	.092	1 5/8	8.802	6.913	3 1/8	32.55	25.57	7	163.3	128.3
1/4	.208	.164	1 11/16	9.492	7.455	3 1/4	35 21	27.65	7 1/4	175.2	137.6
5/16	.326	.256	1 3/4	10.21	8 018	3 3/8	37.97	29.82	7 1/2	187.5	147.3
3/8	.469	.368	1 13/16	10.95	8 601	3 1/2	40.83	32.07	7 3/4	200.2	157.2
7/16	.638	.501	1 7/8	11.72	9.204	3 5/8	43.80	34.40	8	213.3	167 6
1/2	.833	.654	1 15/16	12 51	9.828	3 3/4	46.88	36.82	8 1/4	226.9	178.2
9/16	1.055	.828	2	13.33	10.47	3 7/8	50.05	39.31	8 1/2	240.8	189 2
5/8	1.302	1.023	2 1/16	14.18	11.14	4	53 33	41.89	8 3/4	255 2	200 4
11/16	1.576	1.237	2 1/8	15.05	11.82	4 1/8	56.72	44.55	9	270.0	212.1
3/4	1.875	1.473	2 3/16	15.95	12.53	4 1/4	60.21	47.29	9 1/4	285.2	224.0
13/16	2.201	1.728	2 1/4	16 88	13.25	4 3/8	63.80	50.11	9 1/2	300.8	236 3
7/8	2.552	2.004	2 5/16	17.83	14.00	4 1/2	67.50	53.01	9 3/4	316.9	248 9
15/16	2.930	2.301	2 3/8	18.80	14.77	4 5/8	71.30	56 00	10	333.3	261 8
1	3.333	2.618	2 7/16	19.80	15.55	4 3/4	75.21	59.07	10 1/4	350.2	275.1
1 1/16	3.763	2.955	2 1/2	20.83	16.36	4 7/8	79.22	62.22	10 1/2	367.5	288.6
1 1/8	4.219	3.313	2 9/16	21.89	17.19	5	83.33	65.45	10 3/4	385.2	302 5
1 3/16	4.701	3.692	2 5/8	22.97	18.04	5 1/4	91.88	72.16	11	403 3	316 8
1 1/4	5.208	4.091	2 11/16	24.08	18.91	5 1/2	100.8	79.19	11 1/4	421.9	331.3
1 5/16	5.742	4.510	2 3/4	25.21	19.80	5 3/4	110.2	86 56	11 1/2	440 8	346.2
1 3/8	6.202	4.950	2 13/16	26.37	20.71	6	120.0	94.25	11 3/4	460.2	361.4
1 7/16	6.888	5.410	2 7/8	27.55	21.64	6 1/4	130.2	102.3	12	480.0	377.0
1 1/2	7.500	5.890	2 15/16	28.76	22.59	6 1/2	140 8	110.6	....	.....	.....
1 9/16	8.138	6.392	3	30.00	23 56	6 3/4	151.9	119.3	.....	.....	.....

Digitized by Google

AREAS AND CIRCUMFERENCES OF CIRCLES.

Diameter.		Area.	Circum.	
Feet.	Inch.	Feet.	Ft.	Inch.
1 ft.		.7854	3	1 5/8
	1	.9217	3	4 5/8
	2	1.069	3	8
	3	1.2271	3	11
	4	1.3962	4	1 1/8
	5	1.5761	4	5 3/8
	6	1.7671	4	8 1/2
	7	1.9689	4	11 5/8
	8	2.1816	5	2 3/4
	9	2.4052	5	5 7/8
	10	2.6398	5	9
	11	2.8852	6	2 1/4
2 ft.		3.1416	6	2 3/8
	1	3 4087	6	6 1/2
	2	3.6869	6	9 5/8
	3	3.976	7	3/8
	4	4.276	7	3 7/8
	5	4 5869	7	7
	6	4 9087	7	10 1/4
	7	5 2413	8	1 3/8
	8	5.585	8	4 1/2
	9	5 9395	8	7 5/8
	10	6.3049	8	10 3/4
	11	6.6813	9	1 7/8
3 ft.		7.0686	9	5
	1	7.4666	9	8 1/4
	2	7.8757	9	11 3/8
	3	8.2957	10	2 1/2
	4	8.7265	10	5 5/8
	5	9.1683	10	8 3/4
	6	9 6214	10	11 7/8
	7	10.0816	11	3
	8	10.5591	11	6 1/8
	9	11.0446	11	9 3/8
	10	11.5409	12	1/2
	11	12 0481	12	3 5/8
4 ft.		12.5664	12	6 3/4
	1	13 0952	12	9 7/8
	2	13.6353	13	1
	3	14.1862	13	4 1/8
	4	14 7479	13	7 1/4
	5	15.3206	13	10 1/2
	6	15 9043	14	1 5/8
	7	16.4986	14	4 5/8
	8	17.1041	14	7 7/8

Diameter.		Area.	Circum	
Feet.	Inch.	Feet.	Ft.	Inch.
4 ft.	9	17.7205	14	11
	10	18.3476	15	2 1/8
	11	18.9858	15	5 1/4
5 ft.		19.635	15	8 1/8
	1	20.2947	15	11 5/8
	2	20.9656	16	2 3/4
	3	21.6475	16	5 3/4
	4	22 34	16	9
	5	23.0437	17	1/8
	6	23.7583	17	3 1/4
	7	24.4835	17	6 3/8
	8	25 2199	17	9 5/8
	9	25.9672	18	3/4
	10	26 7251	18	3 7/8
	11	27.4943	18	7 1/8
6 ft		28 2744	18	10 1/8
	1	29.0649	19	1 1/4
	2	29.8668	19	4 3/8
	3	30.6796	19	7 1/2
	4	31.5029	19	10 5/8
	5	32.3376	20	1 7/8
	6	33.1831	20	4 7/8
	7	34.0391	20	8 1/8
	8	34.9065	20	11 1/2
	9	35.7847	21	2 3/8
	10	36.6735	21	5 1/2
	11	37.5736	21	8 3/4
7 ft.		38.4846	21	11 7/8
	1	39.406	22	3
	2	40.3388	22	6 1/8
	3	41.2825	22	9 1/4
	4	42.2367	23	3/8
	5	43 2022	23	2 1/8
	6	44 1787	23	6 3/4
	7	45 1656	23	11
	8	46.1638	24	1 1/8
	9	47.173	24	4 1/8
	10	48.1926	24	7 1/4
	11	49.2236	24	10 3/8
8 ft.		50.2656	25	1 1/2
	1	51.3178	25	4 5/8
	2	52 3816	25	7 7/8
	3	53.4562	25	11
	4	54.5412	26	2 1/8
	5	55.6377	26	5 1/4

Digitized by Google

AREAS AND CIRCUMFERENCES OF CIRCLES—Continued.

Diameter		Area.	Circum.	
Feet.	Inch.	Feet.	Ft.	Inch.
8 ft.	6	56 7451	25	8⅜
	7	57.8628	26	11½
	8	58 992	27	2¾
	9	60 1321	27	5¾
	10	61.2826	27	9
	11	62 4445	28	⅛
9 ft.		63.6174	28	3¼
	1	64.8006	28	6⅜
	2	65 9951	28	9½
	3	67.2007	29	⅝
	4	68.4166	29	3¾
	5	69 644	29	7
	6	70.8823	29	10⅛
	7	72 1309	30	1¼
	8	73.391	30	4⅜
	9	74.662	30	7½
	10	75.9433	30	11⅝
	11	77.2362	31	1¾
10 ft.		78.54	31	5
	1	79 854	31	8⅛
	2	81.1795	31	11¼
	3	82 516	32	2⅜
	4	83 8627	32	5½
	5	85.2211	32	8⅝
	6	86.5903	32	11¾
	7	87.9697	33	2⅞
	8	89.3608	33	6⅛
	9	90 7627	33	9¼
	10	92.1749	34	⅜
	11	93 5986	34	3½
11 ft.		95 0334	34	6⅝
	1	96.4783	34	9¾
	2	97.9347	35	⅞
	3	99.4021	35	4⅛
	4	100.0767	35	7¼
	5	102 3689	35	10⅝
	6	103.8691	36	1½
	7	105.3794	36	4½
	8	106 9013	36	7¾
	9	108 4342	36	10⅞
	10	109.9772	37	2¾
	11	111.5319	37	5¼
12 ft.		113.0976	37	8⅜
	1	114.6732	37	11½
	2	116 2607	38	2⅝

Diameter		Area.	Circum.	
Feet.	Inch.	Feet.	Ft.	Inch.
12 ft.	3	117.8590	38	5¾
	4	119.4674	38	8⅞
	5	121.0876	39	0
	6	122.7187	39	3¼
	7	124.3598	39	6⅜
	8	126.0127	39	9½
	9	127.6765	40	⅝
	10	129.3504	40	3¾
	11	131.0360	40	6⅞
13 ft.		132.7326	40	10
	1	134 4391	41	1⅛
	2	136.1574	41	4⅜
	3	137.8867	41	7½
	4	139.6260	41	10⅝
	5	141.3771	42	1⅜
	6	143.1391	42	4⅞
	7	144 9111	42	8
	8	146.6949	42	11⅛
	9	148.4890	43	2¼
	10	150.2943	43	5½
	11	152.1109	43	8⅝
14 ft.		153.9384	43	11¾
	1	155 7758	44	2⅞
	2	157.6250	44	6
	3	159.4852	44	9⅛
	4	161.3553	45	¼
	5	163.2373	45	3½
	6	165.1303	45	6⅝
	7	167 0331	45	9¾
	8	168.9479	46	⅞
	9	170 8735	46	4
	10	172.8091	46	7⅛
	11	174.7565	46	11¼
15 ft.		176.715	47	1½
	1	178 6832	47	4⅝
	2	180.6634	47	7¾
	3	182.6545	47	10½
	4	184.6555	48	2½
	5	186.6684	48	5⅛
	6	188.6923	48	8¼
	7	190 726	48	11⅜
	8	192.7716	49	2⅝
	9	194.8282	49	5¾
	10	196.8946	49	8⅞
	11	198.973	50	0

Digitized by Google

AREAS AND CIRCUMFERENCES OF CIRCLES—Continued.

Diameter.		Area.	Circum.	
Feet.	Inch.	Feet.	Ft.	Inch.
16 ft.		201.0624	50	3⅛
	1	203.1615	50	6¼
	2	205.2726	50	9⅜
	3	207.3946	51	½
	4	209.5264	51	3¾
	5	211.6703	51	6½
	6	213.8251	51	10
	7	215.9896	52	1⅛
	8	218.1662	52	4¼
	9	220.3537	52	7⅜
	10	222.551	52	10½
	11	224.7603	53	1⅝
17 ft.		226.9806	53	4⅞
	1	229.2105	53	8
	2	231.4525	53	11⅛
	3	233.7055	54	2⅛
	4	235.9682	54	5⅜
	5	238.243	54	8½
	6	240.5287	54	11⅝
	7	242.8241	55	2⅞
	8	245.1316	55	6
	9	247.45	55	9⅛
	10	249.7781	56	¼
	11	252.1184	56	3½

Diameter.		Area.	Circum.	
Feet.	Inch.	Feet.	Ft.	Inch.
18 ft.		254.4696	56	6½
	1	256.8303	56	9⅝
	2	259.2033	57	⅞
	3	261.5872	57	4
	4	263.9807	57	7⅛
	5	266.3864	57	10¼
	6	268.8031	58	1⅜
	7	271.2293	58	4½
	8	273.6678	58	7⅝
	9	276.1171	58	10¾
	10	278.5761	59	2
	11	281.0472	59	5⅛
19 ft.		283.5294	59	8¼
	1	286.021	59	11½
	2	288.5249	60	2½
	3	291.0397	60	5⅝
	4	293.5641	60	8¾
	5	296.1107	60	11⅞
	6	298.6483	61	3⅛
	7	301.2054	61	6¼
	8	303.7747	61	9¼
	9	306.355	62	½
	10	308.9448	62	3⅝
	11	311.5469	62	6¾
20 ft.		314.16	62	9⅞

NUMBER OF RIVETS IN 100 POUNDS.

Lengths.	⅜ in.	$\frac{7}{16}$ in.	½ in.	$\frac{9}{16}$ in.	⅝ in.	$\frac{11}{16}$ in.	¾ in.	⅞ in.
¾	1,965	1,419	1,092	944	665			
⅞	1,848	1,335	1,027	846	597			
1	1,692	1,222	940	763	538	450		
1¼	1,437	1,036	797	691	487	389	356	228
1½	1,300	949	730	624	440	357	280	180
1¾	1,200	900	693	553	390	325	262	169
2	1,100	789	608	511	360	297	243	156
2¼	999	721	555	491	347	280	232	149
2½	945	682	525	475	335	260	220	141
2¾	900	650	500	443	312	242	208	133
3	828	598	460	411	290	224	197	127
3¼	779	562	433	379	267	212	180	115
3½	743	536	413	352	248	201	169	108
3¾	715	513	395	341	241	192	160	102

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

89035557750

b89035557750a

Digitized by Google

Digitized by Google

89035557750

b89035557750a

Digitized by Google

ELLIOTT, PHILA.